AIR SCIENCES INC.

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Resolution Copper Mining Monitoring Plan – Revision 2

PREPARED FOR:
RESOLUTION COPPER
A MEMBER OF
RIO TINTO GROUP

Resolution Copper Mining

PREPARED BY:
AIR SCIENCES INC.

PROJECT NO. 262-21
MARCH 2016

A. PROJECT MANAGEMENT ELEMENTS

Resolution Copper Mining Monitoring Plan (MP)

A.1 Title and Approval Sheet

Kami Ballard Project Director Resolution Copper Mining	Date
Rory Attridge Project Manager Air Sciences Inc.	Date
Dave Randall Project Oversight Air Sciences Inc.	Date
Michael Sundblom Director Pinal County Air Quality Control District	Date

A.2 Table of Contents

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A.3 Distribution List

The names and contact information for all personnel who contribute to this monitoring plan are listed in Table 1. Each individual on the distribution list will receive a copy of the monitoring plan and will also receive any revisions made to the document.

Table 1. Program Principals

Key Project Individuals	Contact Information
Kami Ballard Environmental and Permitting Specialist and Program Director Resolution Copper Company	102 Magma Heights Superior, AZ 85273 520-689-3318 kami.ballard@riotinto.com
Rory Attridge Senior Aerometric Monitoring Scientist and Project Manager Air Sciences Inc.	601 Corporate Circle, Unit D Golden, CO 80401 720-389-4222 rattridge@airsci.com
Dave Randall Principal Air Quality Scientist and Project Oversight Air Sciences Inc.	601 Corporate Circle, Unit D Golden, CO 80401 720-389-4221 drandall@airsci.com
Aaron Schlabaugh Senior Air Quality Engineer and Quality Assurance Manager Air Sciences Inc.	601 Corporate Circle, Unit D Golden, CO 80401 720-389-4225 aschlabaugh@airsci.com
Michael Sundblom Director Pinal County Air Quality Control District	31 N. Pinal Street, Building F Florence, AZ 85132 520-866-6915 Michael.Sundblom@pinalcountyaz.gov

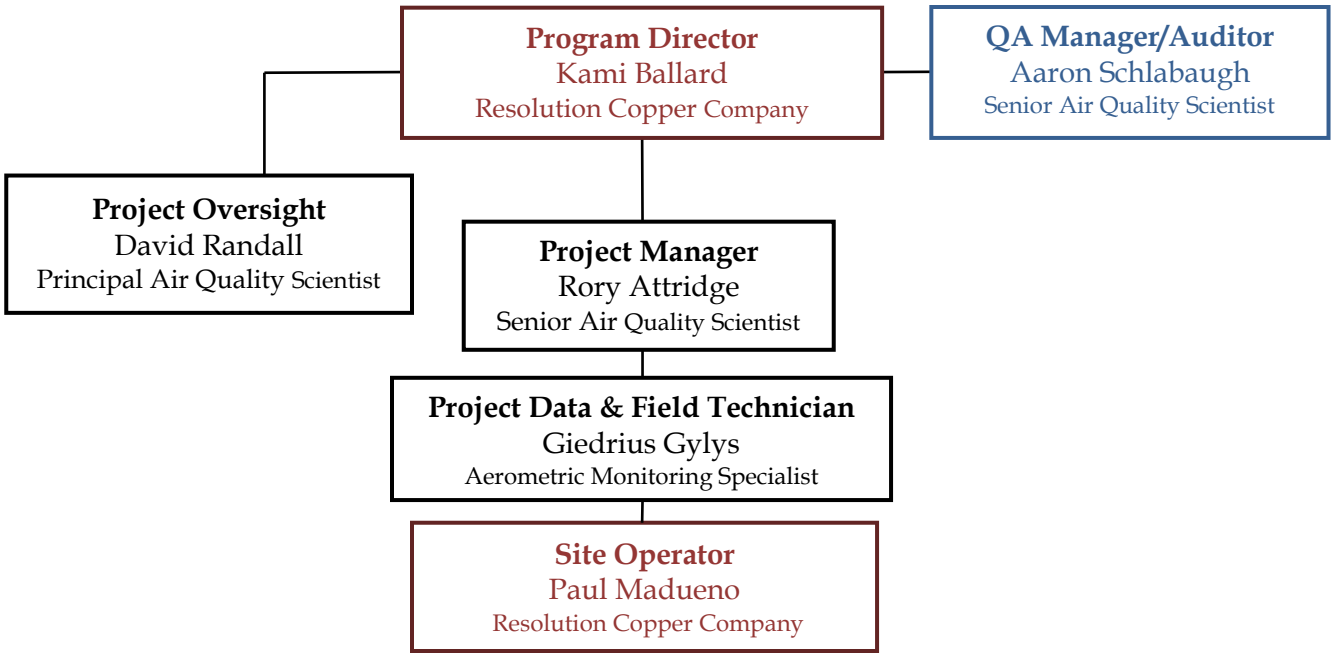
A.4 Project Task/Organization

Air Sciences Inc. (Air Sciences) is assisting Resolution Copper Company (RCC) in the installation, operation, and maintenance of multiple ambient air and meteorological monitoring stations associated with the Resolution Copper Mine in Superior, Arizona. The monitoring program at each RCC site includes a high level of quality control as required by the United States Environmental Protection Agency (EPA) and State of Arizona guidelines. Data collection and processing are performed by an experienced team. The program contributors are listed in Table 2 and Figure 1.

Table 2. Project Task/Organization

Project Individuals	Roles and Responsibilities	Reports To:
Program Director Kami Ballard	Performs supervisory role. Holds overall project responsibility and decision-making authority over project plan. Communicates with agencies.	
Project Manager Rory Attridge	Provides draft and final copy of project monitoring plan. Provides administrative project control. Manages field engineers and technicians. Conducts final review and certification of data.	Program Director
Project Oversight Dave Randall	Provides project administrative support. Lends guidance on regulatory issues and provides input on monitoring data and how data applies to modeling, permitting, and compliance.	Program Director
QA Auditor/Manager Aaron Schlabaugh	Assures Quality Assurance/Quality Control (QA/QC) compliance. Ensures that project databases are current. Reviews calibrations and audits reports. Performs second-party audits. Acts as principal contributor to quarterly and annual reports. Provides technical supports as needed.	Project Director
Project Data and Field Technicians Giedrius Gylys	Provide technical support to field crews and site operators. Act as liaisons between field personnel and technical support. Perform daily level-1 QA/QC on incoming data.	Project Manager
Site Operator Paul Madueno	Performs weekly site checks. Notifies Air Sciences' Data Technicians when parameters are out of specification. Conducts scheduled maintenance. Provides local presence for quick response to problems.	Project Manager

Figure 1. Project Plan Organizational Chart



A.5 Problem Definition/Background

Resolution Copper Mining LLC (RCML) is overseeing a meteorological and air quality monitoring program to support several efforts during the mine development phases: environmental assessments, impact analyses, and documents required by the National Environmental Policy Act (NEPA); meteorological and air quality data to be processed and used as input for AERMOD (American Meteorological Society/Environmental Protection Agency Regulatory Model) dispersion modeling; and air quality baseline data and AERMOD analyses in support of RCML's application to the Pinal County Air Quality Control District (PCAQCD) for air permit(s).

This monitoring plan includes details of installation, operation, maintenance, and/or regulatory requirements of multiple monitoring stations in areas of potential emission sources for RCML facilities. The monitoring stations include the following:

- East Plant Monitoring Station – Existing station already in operation
- West Plant Monitoring Station – Existing station already in operation
- Hewitt Monitoring Station – Station deployed October 2014; data collection began January 1, 2015, to supplement data collected at the East, West, and Far West stations

- Far West Monitoring Station – Station deployed March 2016; data collection began April 1, 2016

The monitoring stations are listed in Table 3, along with the associated measured parameters.

Table 3. Monitoring Stations

		West Plant	East Plant	Hewitt	Far West
AERMOD Meteorological Data	Horizontal wind speed (meters per second [m/s])	✓	✓	✓	✓
	Horizontal wind direction (degrees[°])	✓	✓	✓	✓
	Horizontal wind direction standard deviation (sigma theta)	✓	✓	✓	✓
	Air temperature (degrees Celsius [°C])	✓	✓	✓	✓
	Vertical temperature difference (ΔT, Delta T, [°C])	✓	✓	✓	✓
	Relative Humidity (percent [%])	✓	✓	✓	✓
	Solar Radiation (watts per square meter [W/m^2])	✓	✓	✓	✓
	Barometric pressure (millimeters of mercury [mmHg])	✓	✓	✓	✓
	Precipitation (inches [in])	✓	✓		
Upper-Air Data	Wind speed by vector component (u, v, w; meters per second [m/s])			✓	
	Wind direction by sub-hourly scalar mean (direction [°])			✓	
	Standard deviation of vector compnent (u, v, w)			✓	
Ambient Air Data	FEM Particulate Matter less than 10 Microns (PM_{10})	✓	✓		✓
	FEM Particulate Matter less than 2.5 Microns ($PM_{2.5}$)	✓	✓		✓
	Sulfur Dioxide (SO_2)		✓		
	Ozone (O_3)		✓		
	Nitrogen Dioxide (NO_2)		✓		

The locations of these monitoring stations are shown in Table 5, Figure 4, Figure 5, Figure 6, and Figure 7.

Monitoring is conducted in accordance with the following publications:

- Guidance for Quality Assurance Project Plans (EPA QA/G-5, December 2002)
- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program (EPA-454/B-13-003, May 2013)
- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements (EPA-454/B-08-002, March 2008)
- Transfer Standards for the Calibration of Ambient Air Monitoring Analyzers for Ozone (EPA-454/B-13-004, October 2013)
- Code of Federal Regulations (40 CFR Parts 50 and 58)
- Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD) (EPA-450/4-87-007, May 1987)

- Meteorological Monitoring Guidance for Regulatory Modeling Applications (EPA-454/R-99-005, February 2000)

A.6 Project Task/Description

A.6.1 Description

The primary tasks of this project are to:

1. Monitor, collect, and analyze AERMOD-ready meteorological data at all monitoring stations (East and West Plant sites, Hewitt Station site, and Far West site) for the following parameters:
    a. Wind speed
    b. Wind direction
    c. Wind direction standard deviation (sigma theta)
    d. Temperature (2 and 10 meters [m])
    e. Temperature Differential (DT) (10 m – 2 m)
    f. Solar Radiation (SR)
    g. Relative Humidity (RH)
    h. Barometric Pressure (BP)
    i. Precipitation
2. Monitor, collect, and analyze upper-air (SoDAR[1]) data at the Hewitt Station site
3. Monitor, collect, and analyze accompanying air quality data for the following parameters:
    a. Particulate matter less than 2.5 and 10 microns in diameter ($PM_{2.5}$ and PM_{10}, respectively) at the East Plant, West Plant, and Far West sites
    b. Nitrogen oxides (NO_X), ozone (O_3), and sulfur dioxide (SO_2) data at the East Plant site

The parameters measured, their sampling frequency, and sample averaging periods are listed in Table 4.

[1] Sonic Detection and Ranging (SoDAR) systems use acoustic pulses to measure wind profiles at various sample heights above the ground.

Table 4. Monitoring Parameters, Sampling Frequency, and Averaging Periods

Measured Parameter	Sampling Frequency	Measurement Averaging Period	Reporting Units
Nitrogen Oxides (NO_X)	Continuous	Hourly	parts per billion (ppb)
Ozone (O_3)	Continuous	Hourly	ppb
Sulfur Dioxide (SO_2)	Continuous	Hourly	ppb
Particulate Matter (PM_{10})	Continuous	Hourly	micrograms per cubic meter ($\mu g/m^3$) (STP)[1]
Particulate Matter ($PM_{2.5}$)	Continuous	Hourly	$\mu g/m^3$
SoDAR	1 Acoustic Pulse per Second	15-Minute	Meters/second (m/s) Degrees (°) From
Wind Speed	1-Second Scan	15-Minute	m/s
Wind Direction	1-Second Scan	15-Minute	° From
Temperature (2 m and 10 m)	1-Second Scan	15-Minute	Degrees Celsius (°C)
Temperature Differential (DT) (10 m – 2 m)	1-Second Scan	15-Minute	°C
Solar Radiation (SR)	1-Second Scan	15-Minute	Watts per square meter (W/m^2)
Relative Humidity (RH)	1-Second Scan	15-Minute	Percent (%)
Barometric Pressure (BP)	1-Second Scan	15-Minute (sample)	Millimeters of mercury (mmHg)
Precipitation	1-Second Scan	15-Minute (totalization)	Inches (in)

[1] Data converted to Standard Temperature and Pressure (STP)

These data may be used to support future air dispersion modeling work and to characterize ambient concentrations, existing conditions, and potential contributions from sources for any reportable event (as may be required in future air permit conditions).

The NO_X, SO_2, and O_3 concentrations measured at the East Plant facility are considered representative of those from the West Plant facility, in the Globe/Miami area near Pinto Valley, and from the general region surrounding the Superior area. According to EPA's Guideline on Air Quality Models (40 CFR 51, Appendix W), monitors used to determine ambient background concentrations should be located in the vicinity of the source, and if they are not, a "regional site" may be used to determine background concentrations. The Guideline states that "A 'regional site' is one that is located away from the area of interest, but is impacted by similar natural and distant man-made sources." The East Plant site is not only in the vicinity of the source, but it also meets both regional site criteria because it is affected by similar small nearby emission sources, and it is representative of rural conditions. Thus, the use of ambient air data from the East Plant site to represent ambient background conditions at the project facilities is appropriate.

Figure 2 and Figure 3 provide schematics of sensor heights. All air monitoring equipment is housed in a climate-controlled shelter that is well equipped for internal temperature control and provides easy roof access to inlets and manifolds. The towers are mounted on a poured pad and tip down for easy access for audits and calibrations.

Figure 2. Sensor Heights – East Plant, West Plant, and Far West Stations

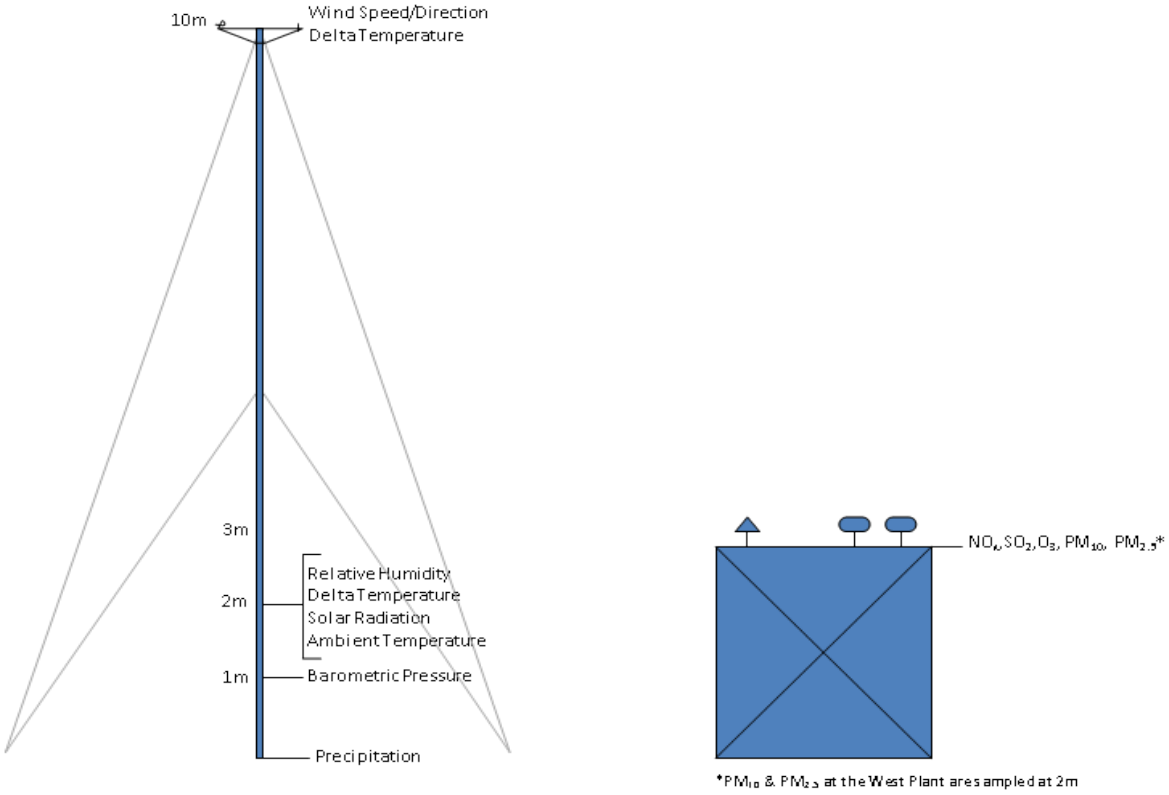
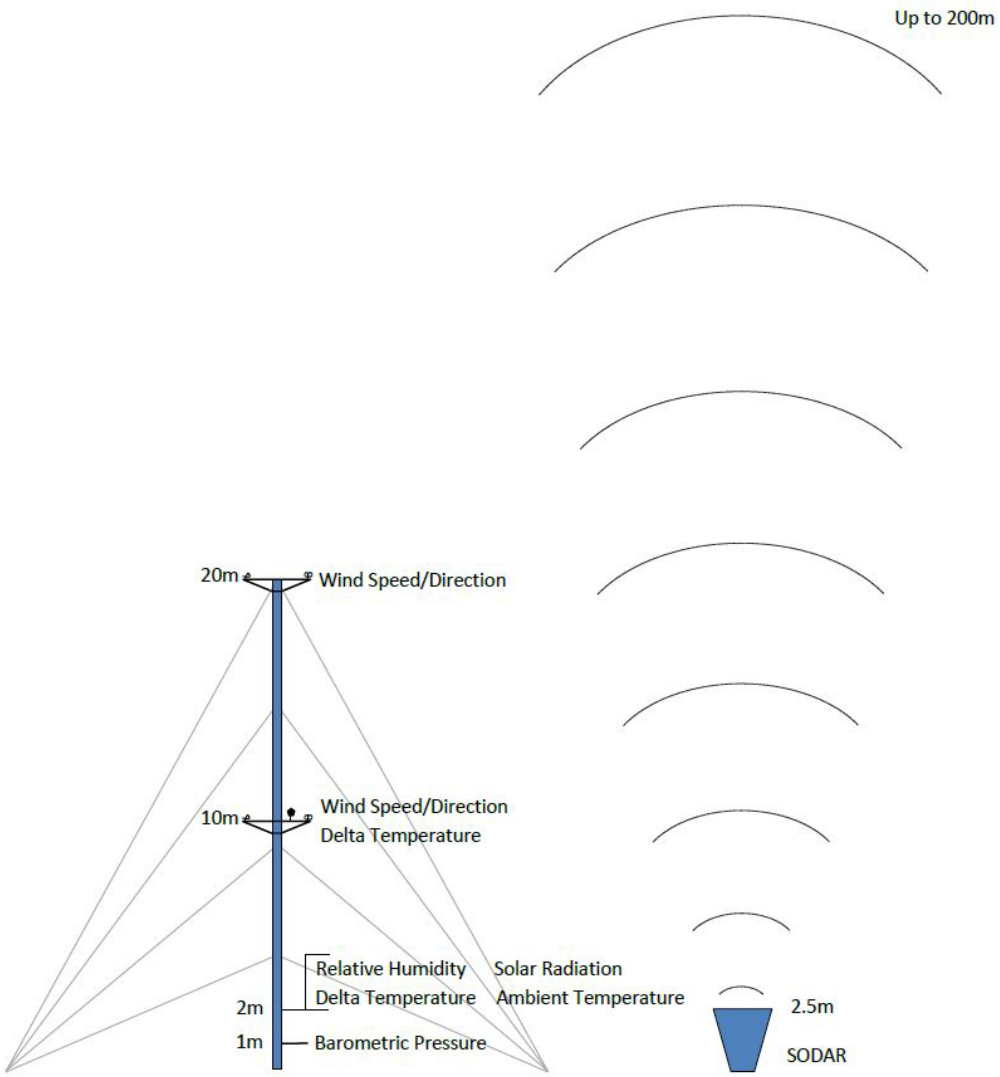


Figure 3. Sensor Heights – Hewitt Station



A.6.2 Monitoring Locations

GPS-derived coordinates for each monitoring station are listed in Table 5. Project location maps for each monitoring station, including topography and surrounding towns and landmarks, are provided in Figure 4, Figure 5, Figure 6, and Figure 7.

Table 5. Station Locations

Station	Location	Latitude (Deg)	Longitude (Deg)	Elevation (f)	Method of Determination
West Plant	S35 T1S R12E	33.2994	-111.1020	2,968	GPS
East Plant	S32 T1S R13E	33.3037	-111.0674	4,176	GPS
Hewitt – SoDAR	S35 T1S R11E	33.2981	-111.2114	2,236	GPS
Hewitt – Met	S35 T1S R11E	33.2978	-111.2109	2,235	GPS
Far West	S36 T2S R9E	33.2107	-111.3769	1,754	GPS

Figure 4. Project Location Map – East Plant, West Plant, Hewitt, and Far West Station Locations

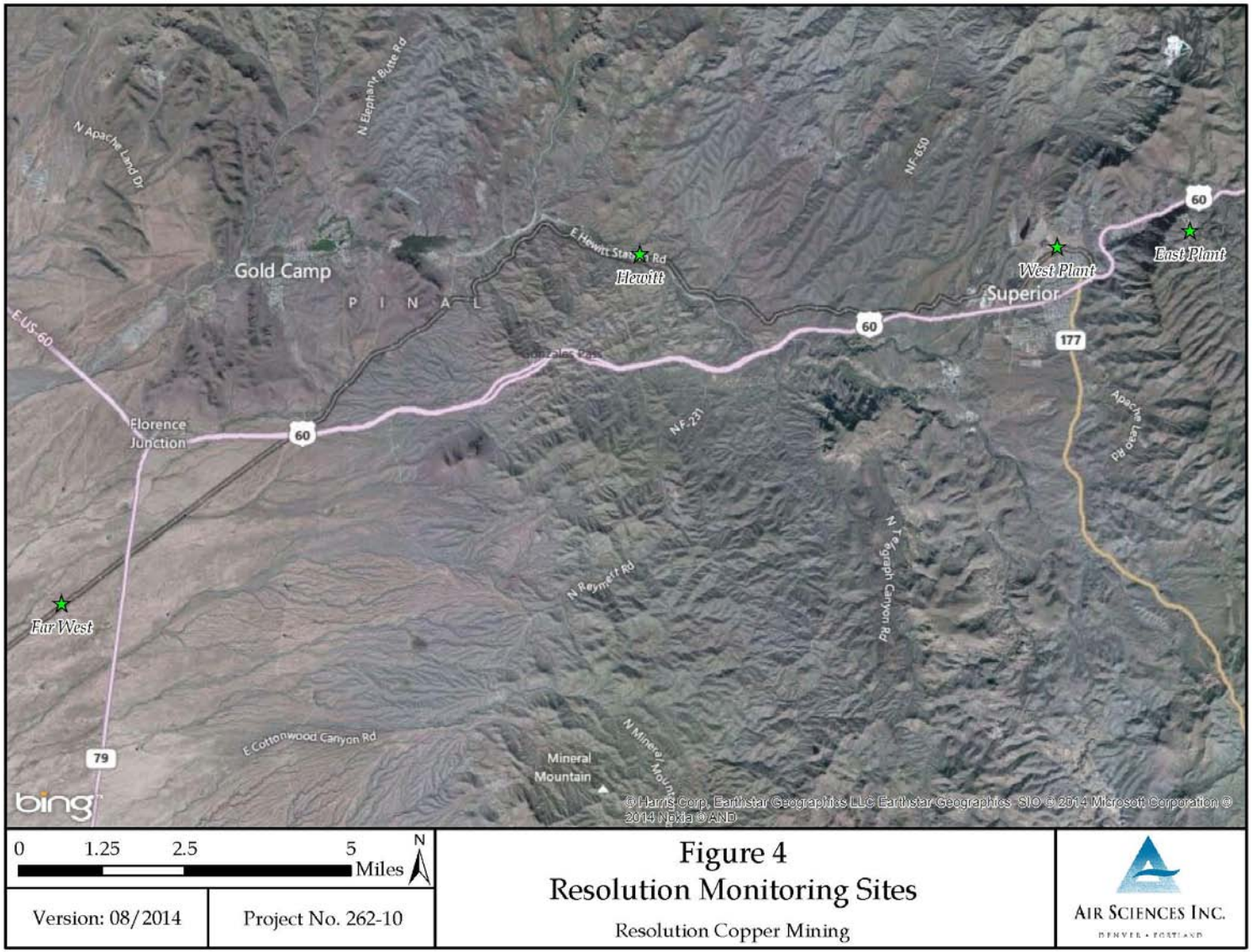


Figure 5. Project Location Map – Zoom-In of Hewitt Station SoDAR and Meteorological Tower Locations

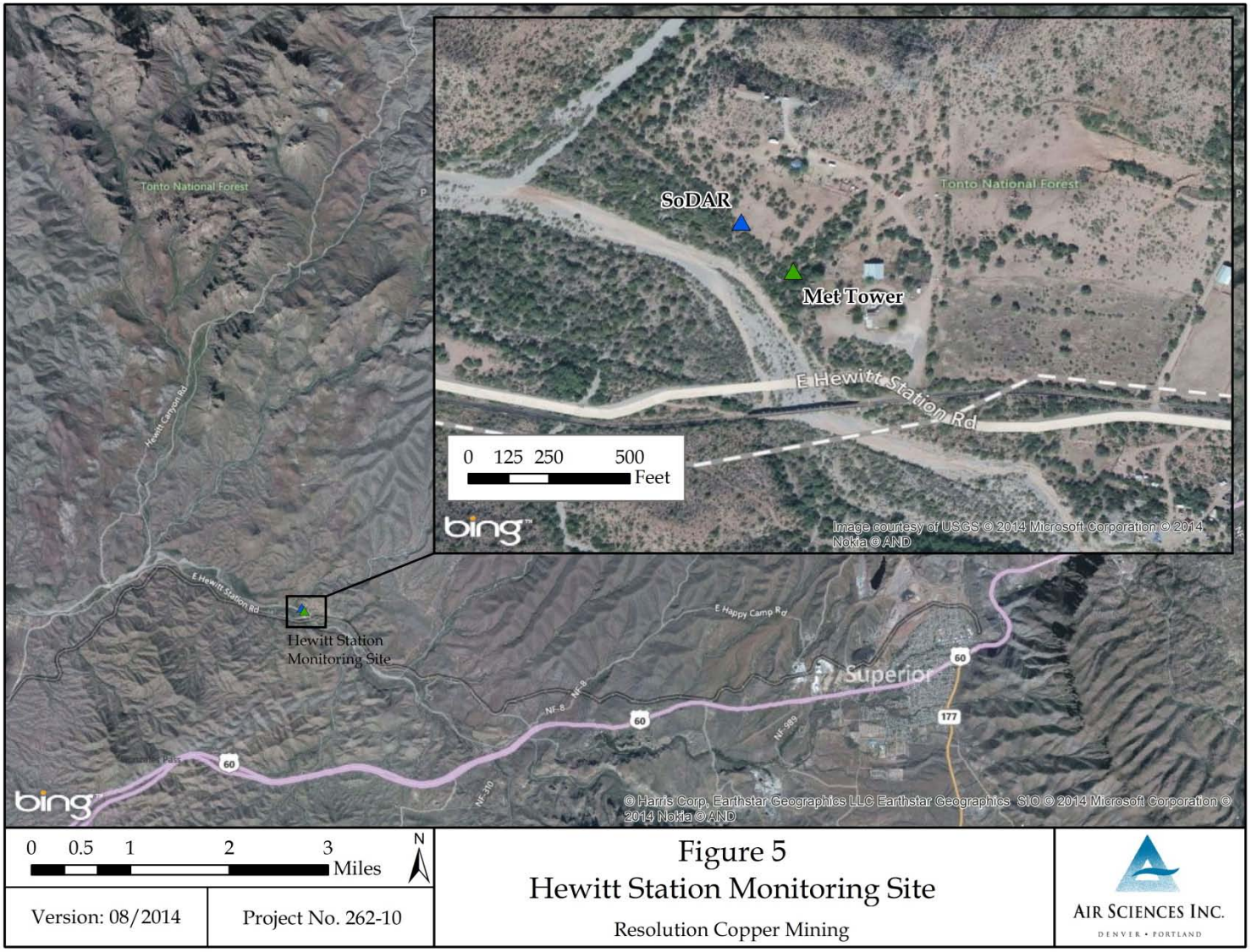
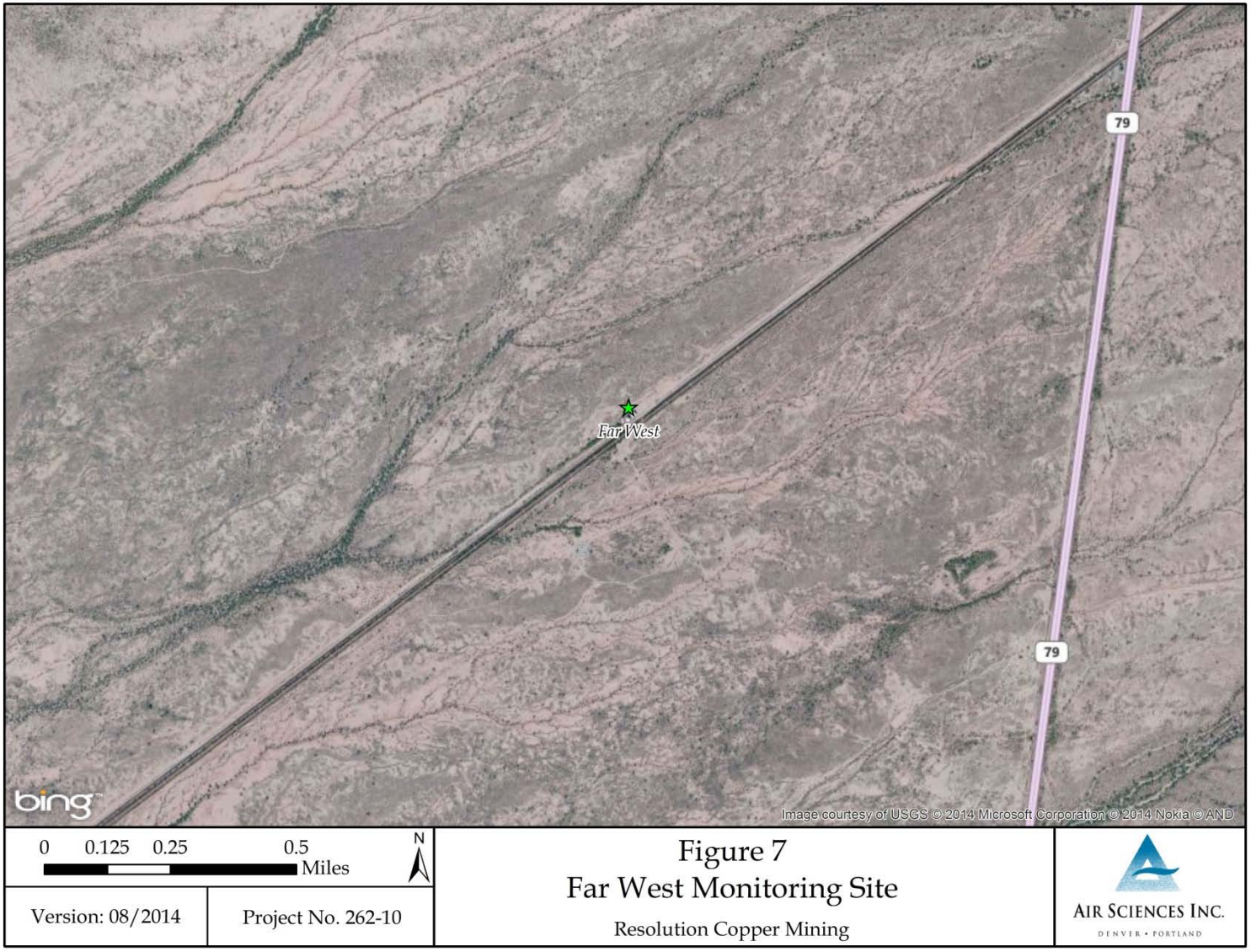


Figure 6. Project Location Map – Zoom-In of East Plant and West Plant Station Locations

Figure 7. Project Location Map – Zoom-In of Far West Plant Station Location



A.6.3 Monitoring Locations with Proposed Mining Overlays

Figure 8 through Figure 11 show the mining layout plans in relation to each monitoring site. Site selection for tailings and other activities are not finalized; the following figures include proposed locations.

Figure 8. Project Location Map – Overview of Monitoring Sites in Relation to Proposed Mine Activities

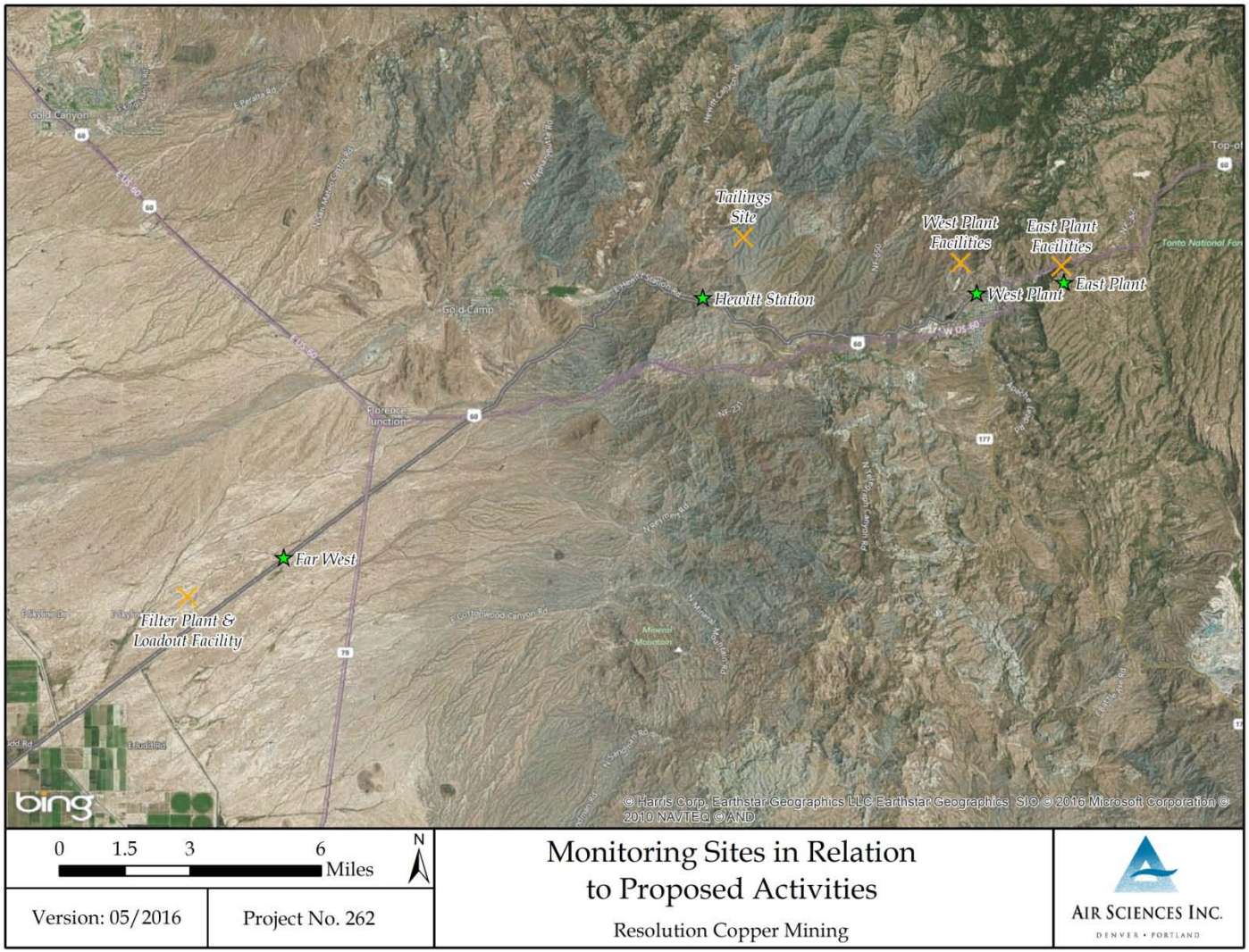


Figure 9. Project Location Map – Approximate Location of Proposed West Plant Facilities (Ore Stockpile/Mill)

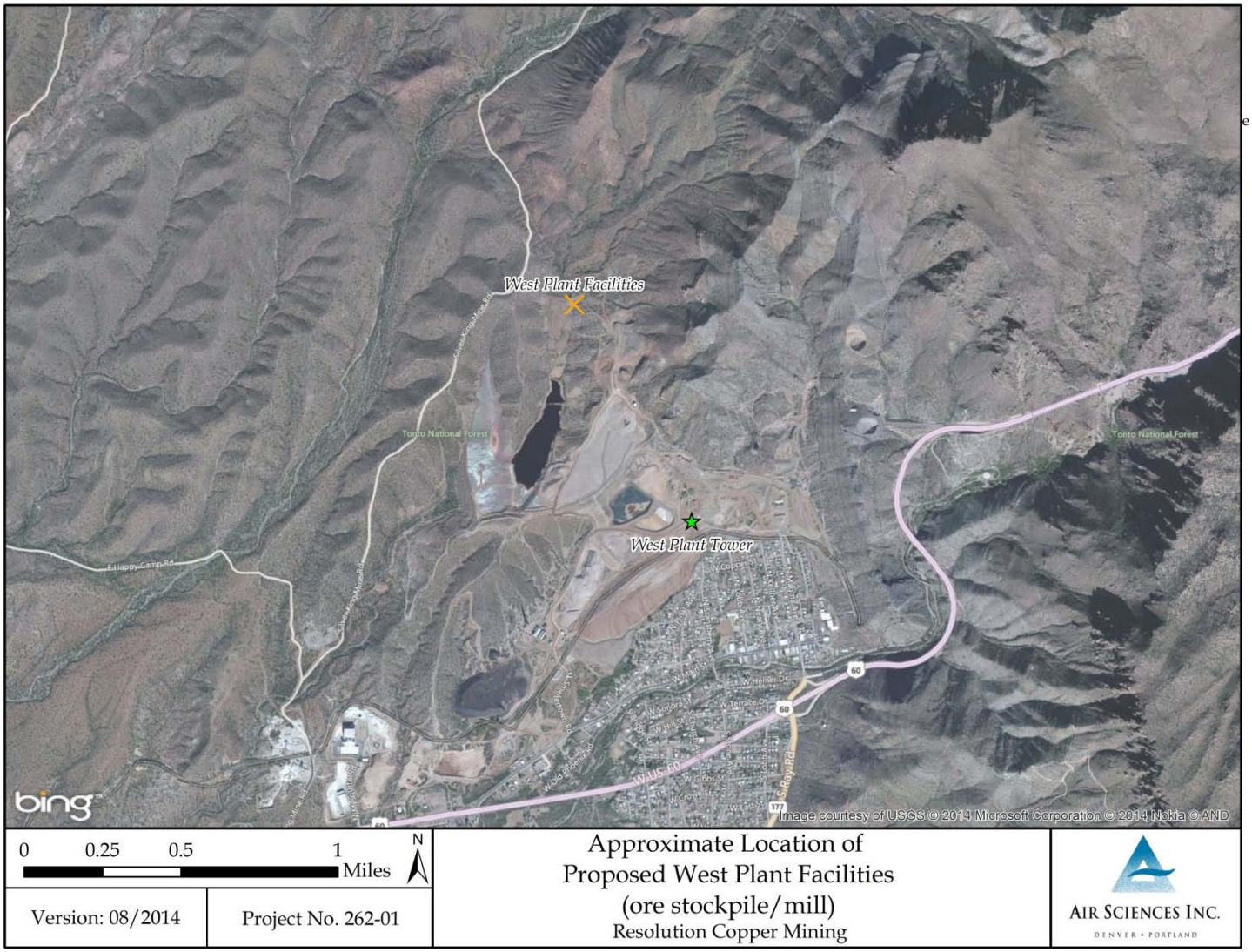


Figure 10. Project Location Map – East Plant/Mine Site (Existing and Proposed)

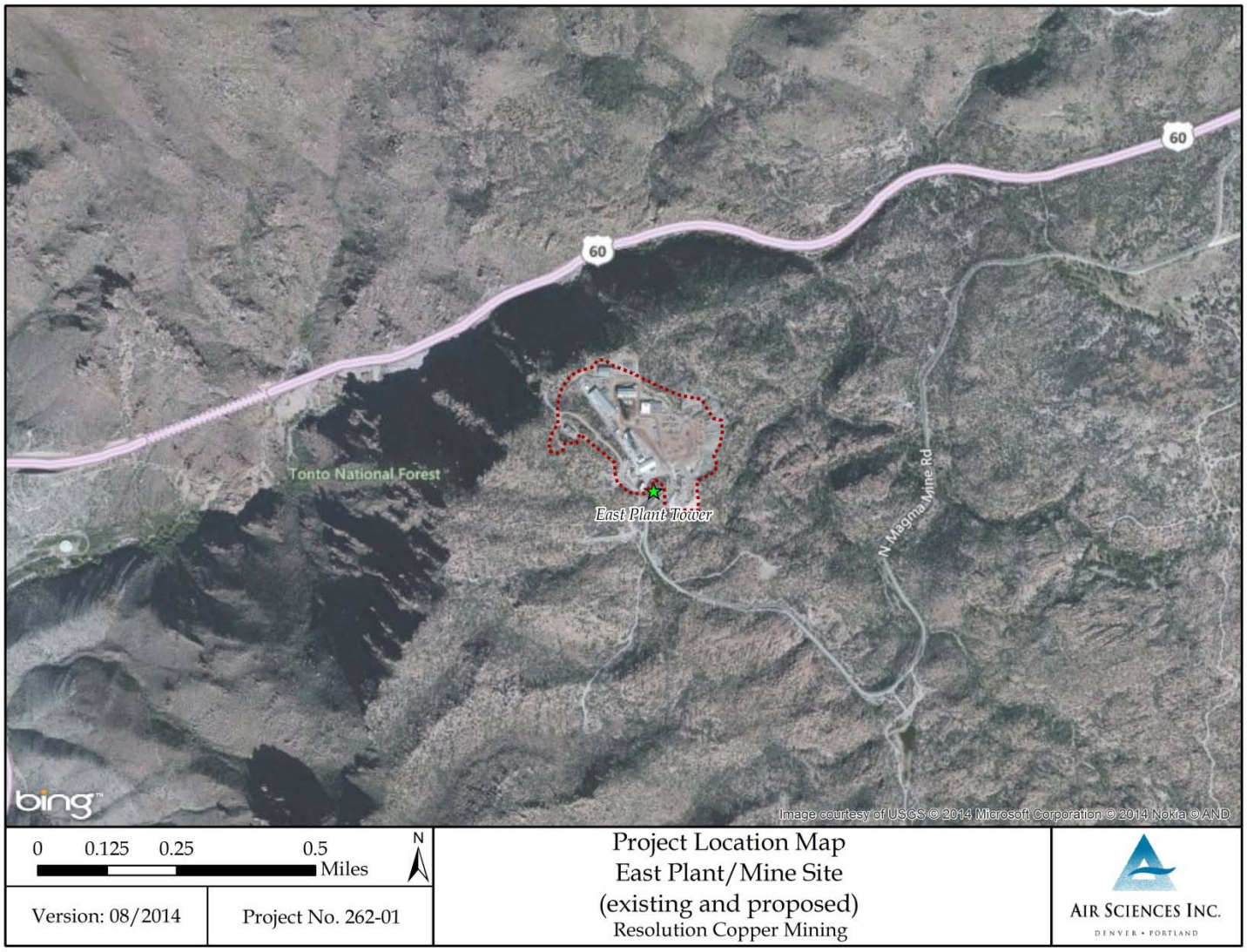


Figure 11. Project Location Map – Far West and Hewitt Stations in Relation to Proposed Tailings Site

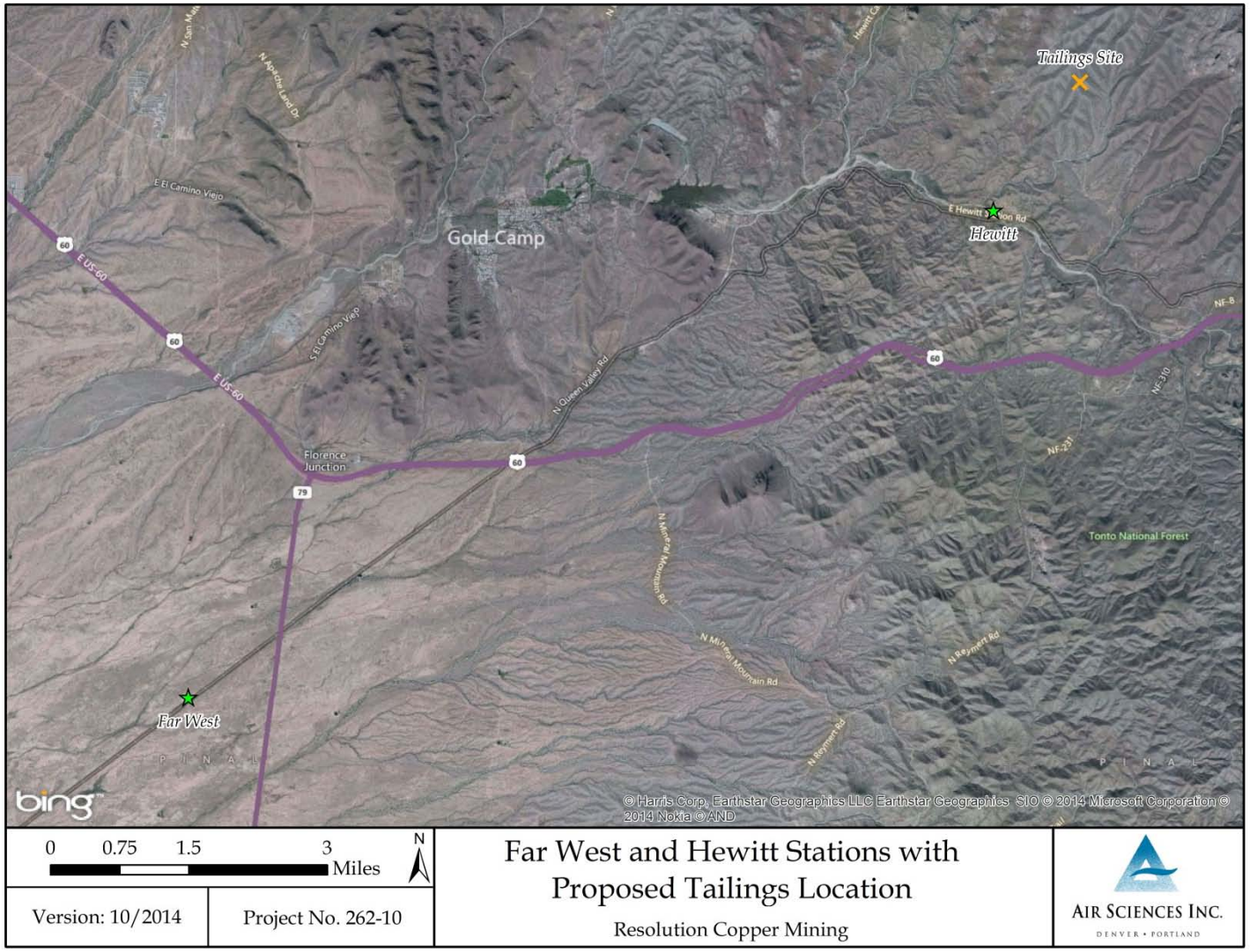
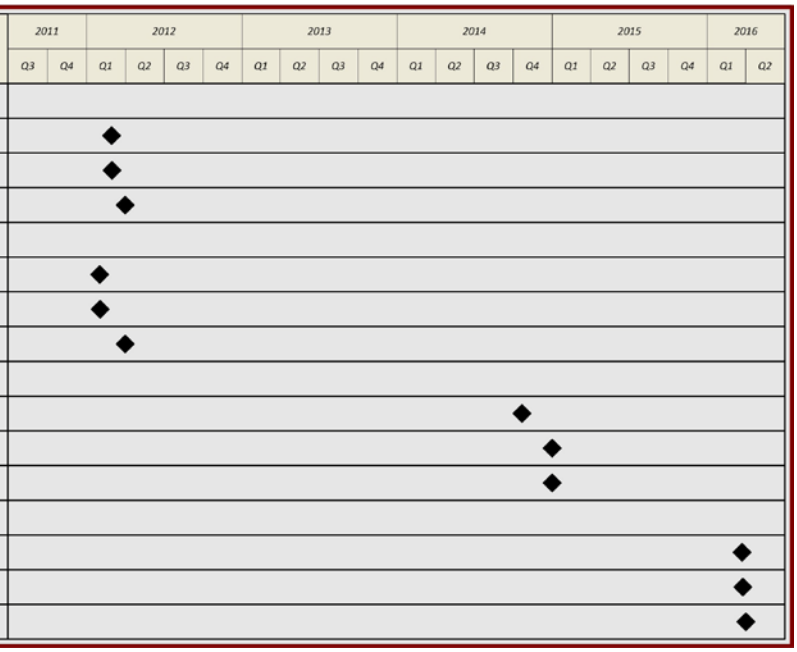


Table 6 provides the project milestones in support of the RCC monitoring program.

Table 6. Project Milestones

	Resolution Air Monitoring Network Milestones	Start Date
1	**East Plant**	
2	Installation	2/29/2012
3	Data Collection	3/1/2012
4	Quarterly Reporting	4/1/2012
5	**West Plant**	
6	Installation	2/1/2012
7	Data Collection	2/2/2012
8	Quarterly Reporting	4/1/2012
9	**Hewitt Station**	
10	Installation	10/22/2014
11	Data Collection	1/1/2015
12	Quarterly Reporting	1/1/2015
13	**Far West**	
14	Installation	3/23/2016
15	Data Collection	3/25/2016
16	Quarterly Reporting	4/1/2016



A.7 Quality Objectives and Criteria

The primary quality objectives for the Resolution monitoring program are taken from EPA guidelines and instrument performance specifications. Data Quality Objectives (DQOs) and Measurement Quality Objectives (MQOs) include instrument performance and acceptance criteria used to support compliance with air quality standards. DQOs and MQOs for each measured parameter (NO_2, O_3, SO_2, PM_{10}, $PM_{2.5}$, meteorology, and upper-air) are listed in Table 7 through Table 13.

1. **Ambient air and particulate matter monitoring quality objectives and criteria** for NO_2, O_3, SO_2, PM_{10}, and $PM_{2.5}$ are described in Sections A.7.1 through A.7.4, and in Table 7 through Table 11. For these measured parameters, these tables include the requirements, frequency of compliance evaluation, acceptance criteria, and details about where the requirement is located or additional guidance about the requirement. The ambient air and particulate matter monitoring DQOs and MQOs in Table 7 through Table 11 are from instrument performance specifications, the EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program (EPA-454/B-13-003, May 2013), and the subsequent updates

provided in July 2014 by the EPA's Ambient Monitoring Technology Information Center (AMTIC) to Appendix D, Measurement Quality Objectives and Validation Templates.[2]

There are three groups of criteria listed in Table 7 through Table 11, described by the EPA as follows:

- **Critical Criteria:** *"Criteria…deemed critical to maintaining the integrity of a sample or group of samples…Observations that do not meet each and every criterion on the Critical Criteria Table should be invalidated unless there are compelling reason and justification for not doing so. The sample or group of samples for which one or more of these criteria are not met is invalid until proven otherwise. The cause of not operating in the acceptable range for each of the violated criteria must be investigated and minimized to reduce the likelihood that additional samples will be invalidated."*

- **Operational Criteria:** *"Criteria that are important for maintaining and evaluating the quality of the data collection system…Violation of a criterion or a number of criteria may be cause for invalidation. The decision maker should consider other quality control information that may or may not indicate the data are acceptable for the parameter being controlled. Therefore, the sample or group of samples for which one or more of these criteria are not met is suspect unless other quality control information demonstrates otherwise. The reason for not meeting the criteria MUST be investigated, mitigated or justified."*

- **Systematic Criteria:** *"…those criteria which are important for the correct interpretation of the data but do not usually impact the validity of a sample or group of samples… the data quality objectives are included in this table. If the data quality objectives are not met, this does not invalidate any of the samples but it may impact the error rate associated with the attainment/non-attainment decision."*

Quality control checks required by regulation must be performed, even if the criteria are deemed Operational or Systematic.

The EPA notes the following regarding use of bold and italic font in Table 7 through Table 13:

> *"The criteria listed in the validation templates are either requirements that can be found in the Code of Federal Regulations, guidance found in a variety of guidance documents, or recommendations by the QA Workgroup or EPA. Any time a CFR requirement is identified in the Requirement, Frequency or Acceptance Criteria column it will be*

[2] http://www3.epa.gov/ttn/amtic/files/ambient/pm25/qa/appd_validation_template_amtic.pdf

identified by bold and italics font. The Information/Action column will provide the appropriate references for CFR or guidance documents."

2. **Meteorological monitoring quality objectives and criteria** are described in Section A.7.5 and Table 12. For these meteorological parameters, this table includes the parameters measured, methods, acceptable operating range, sample/data collection frequency, and required data completeness rate. The meteorological monitoring DQOs and MQOs in Table 12 are from instrument performance specifications and the EPA Meteorological Monitoring Guidance for Regulatory Modeling Applications (EPA-454/R-99-005).

3. **Upper-air monitoring quality objectives and criteria** are described in Section A.7.6 and Table 13. For these upper-air parameters, this table includes the parameters measured, methods, acceptable operating range, sample/data collection frequency, and required data completeness rate. The upper-air monitoring DQOs and MQOs in Table 13 are from instrument performance specifications and EPA-454/R-99-005.

A.7.1 Ambient Air Monitoring – NO_2

This project includes use of the Teledyne API Model T200 $NO/NO_2/NO_X$ Analyzer with the following EPA designation: RFNA-1194-099. This instrument is designed to measure NO_X (with nitrogen dioxide, NO_2, as an indicator) at trace levels in ambient air. The instrument is operated continuously to collect hourly NO, NO_2, and NO_X concentrations on a continuous basis.

The precision of the analyzer is assessed by challenging the instrument with a known concentration of standard gas at least once every two weeks. This precision check can be automated, but the Site Operator or the QA Manager can also perform the span.

The QA Auditor assesses the accuracy of the monitor at least quarterly by performing multi-point audits and evaluating the operation of the system. Data completeness (percent) is assessed by dividing the number of valid run days by the amount of run days that exist for the quarter, and then multiplying that number by 100. The DQO for data completeness is 75 percent for the quarter.

In the event of a sampler malfunction, steps are initiated immediately upon discovery to remedy the malfunction. The Program Director is notified within 24 hours of discovery of failure if immediate repair is unattainable. Information in the notification to the Program Director includes the reason for the malfunction and the plan for replacement or repair.

The DQOs and MQOs for NO_2 are listed in Table 7.

A.7.2 Ambient Air Monitoring – O_3

This project includes use of the Teledyne API Model T400 O_3 Analyzer with the following EPA designation: EQOA-0992-087. This instrument is designed to measure O_3 at trace levels in ambient air. The instrument is operated to collect hourly O_3 concentrations on a continuous basis.

The precision of the analyzer is assessed by challenging the instrument with an internal ozone generator at least once every two weeks. This precision check can be automated, but the Site Operator or the QA Manager can also perform the span.

The QA Auditor assesses the accuracy of the monitor at least quarterly by performing multi-point audits and evaluating the operation of the system using a certified transfer standard. Data completeness (percent) is assessed by dividing the number of valid run days by the amount of run days that exist for the quarter, and then multiplying that number by 100. The DQO for data completeness is 75 percent for the quarter.

In the event of a sampler malfunction, steps are initiated immediately upon discovery to remedy the malfunction. The Program Director is notified within 24 hours of discovery of failure if immediate repair is unattainable. Information in the notification to the Program Director includes the reason for the malfunction and the plan for replacement or repair.

The DQOs and MQOs for O_3 are listed in Table 8.

A.7.3 Ambient Air Monitoring – SO_2

This project includes use of the Teledyne API Model T100 SO_2 Analyzer with the following EPA designation: EQSA-0495-100. This instrument is designed to measure SO_2 at trace levels in ambient air. The instrument is operated to collect hourly SO_2 concentrations on a continuous basis.

The precision of the analyzer is assessed by challenging the instrument with a known concentration of standard gas at least once every two weeks. This precision check can be automated, but the Site Operator or the QA Manager can also perform the span.

The QA Auditor assesses the accuracy of the monitor at least quarterly by performing multi-point audits and evaluating the operation of the system. Data completeness (percent) is assessed by dividing the number of valid run days by the amount of run days that exist for the quarter, and then multiplying that number by 100. The DQO for data completeness is 75 percent for the quarter.

In the event of a sampler malfunction, steps are initiated immediately upon discovery to remedy the malfunction. The Program Director is notified within 24 hours of discovery of

failure if immediate repair is unattainable. Information in the notification to the Program Director includes the reason for the malfunction and the plan for replacement or repair.

The DQOs and MQOs for SO_2 are listed in Table 9.

A.7.4 Particulate Matter Monitoring – PM_{10} and $PM_{2.5}$

This project includes use of two Beta Attenuation Monitors (BAM-1020 monitors), the first of which is configured as a $PM_{2.5}$ Federal Equivalent Method (FEM) (EQPM-0308-170). The second BAM-1020 monitor is configurable as a $PM_{2.5}$ FEM (EQPM-0308-170), but it is set to monitor PM_{10}. The instruments are operated continuously to collect hourly PM_{10} and $PM_{2.5}$ concentrations every day.

Data completeness (percent) is assessed by dividing the number of valid run days by the amount of run days that exist for the quarter, and then multiplying that number by 100. The DQO for data completeness is 75 percent for the quarter.

The QA Auditor assesses the accuracy of the PM monitors by auditing the flow rate with a certified flow transfer standard at least quarterly. In addition, monthly checks are performed by the Site Operator.

In the event of a sampler malfunction, steps are initiated immediately upon discovery to remedy the malfunction. The Program Director is notified within 24 hours of discovery of failure if immediate repair is unattainable. Information in the notification to the Program Director includes the reason for the malfunction and the plan for replacement or repair.

Comparability requirements for $PM_{10\text{-}2.5}$ are assured through the EPA designation EQPM-0308-170. The accuracy of the monitors is assessed through monthly audits of the flow rate by using a certified flow transfer standard.

The DQOs and MQOs for PM_{10} and $PM_{2.5}$ are listed in Table 10 and Table 11, respectively.

A.7.5 Meteorological Monitoring

The MQOs for the Resolution project's meteorological monitoring system are defined according to EPA-454/R-99-005, Sections 3 and 5. Data completeness (percent) is assessed by dividing the number of valid run days by the amount of run days that exist for the quarter, and then multiplying that number by 100. The DQO for data completeness is 90 percent for the quarter.

The system performance is assessed by the QA Auditor semi-annually (twice a year) in the form of rotating audits and calibrations.

In the event of sensor or datalogger malfunction, steps are initiated immediately upon discovery to remedy the malfunction. The Program Director is notified within 24 hours of

discovery of failure if immediate repair is unattainable. Information in the notification to the Program Director includes the reason for the malfunction and the plan for replacement or repair.

Accuracy and precision of the meteorological parameters measured for this project are assured through proper calibration and maintenance procedures. The accuracy of the sensors is challenged by comparison and collocation with certified transfer standards. The precision and bias of the sensors used are controlled by having selected sensors that meet the performance specifications in EPA-454/R-99-005.

The DQOs and MQOs for meteorological parameters are listed in Table 12.

A.7.6 Upper-Air Meteorological Monitoring

For this project, the Atmospheric Systems Corporation's 4000we SoDAR is used to measure upper-air parameters. The SoDAR uses an array of speakers to emit and receive three steered beams of high-intensity sound pulses at a frequency of 4500 Hz. The instrument samples the atmospheric echo from the pulses and measures the Doppler shift and intensity of the beam. The instrument uses internally programmed algorithms to process the signals into wind component information.

The DQOs for upper-air parameters are based on instrument performance specifications, modeling/analysis needs, and the suggested DQOs outlined in EPA-454/R-99-005, Section 9.3.1.

The SoDAR location was determined based on program objectives, site security, proximity to adjacent tower, SoDAR system operation interferences, and manufacturer recommendations. System performance audits are performed semi-annually (twice a year) according to manufacturer-recommended procedures and the procedures outlined in EPA-454/R-99-005, Sections 9.5 and 9.6.2.

To quantify the reasonableness of the data, the SoDAR data are compared to the data collected from an adjacent tower. Using this approach, at least 24 hours of data between the tower and SoDAR are compared at the 20-meter level. This comparison provides an overall evaluation of the SoDAR performance and a means for detecting potential active and passive noise sources.

Quantitative screening of the data is performed to identify outliers or data that are possibly in error or otherwise appear questionable resulting from meteorological conditions, differences due to problems in one or both instruments, or differences due to sampling techniques and data reduction protocols.

During periods of calm winds, the adjacent tower's mechanical wind monitor floats within its measurement range, which results in less accurate measurements at very low wind speeds

resulting in a significant difference between the compared values of the two systems. The vector wind speed and direction comparisons between the SoDAR and the adjacent tower should be applied only when the adjacent tower recorded wind speeds are greater than four meters per second.

Comparison results that exceed the data quality objectives do not necessarily mean that the data are invalid. A final review of the data is performed by an experienced scientist who understands the methods used to collect the data and who is knowledgeable about the kinds of meteorological conditions expected to be revealed in the data. The DQOs are met depending on the reasons for and magnitude of the differences in data, as well as the anticipated uses of the data.

Data completeness is assessed by dividing the number of valid hourly averages by the number of hours available during the monitoring period, and then multiplying that number by 100. The DQO for data completeness is 90 percent for designated measurement heights per quarter.

In the event of SoDAR malfunction, immediate steps are taken to repair the unit. The Program Director is notified within 24 hours of discovery of failure if immediate repair is unattainable. Information in the notification to the Program Director includes the reason for the malfunction and the plan for replacement or repair.

The DQOs and MQOs for upper-air parameters are listed in Table 13.

Table 7. NO_X Collection Measurement and Data Quality Objectives

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information/Action
CRITICAL CRITERIA – NO_2			
One Point QC Check Single Analyzer	***1/2 weeks***	≤ ±15% (percent difference)	1 and 2) 40 CFR Part 58 App A Section 3.2 3) Recommendation based on DQO in 40 CFR Part 58 App A Section 2.3.1.5 QC Check Conc. range 0.01 - 0.10 ppm Relative to routine concentrations
Zero/Span Check	1/2 weeks	Zero drift ≤ ±3.0 ppb (24 hr) ≤ ±5.0 ppb (>24hr-14 day) Span drift ≤ ±10%	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO
Converter Efficiency	During multi-point calibrations, span and audit 1/2 weeks	***(≥96%)*** 96%-104%	1) 40 CFR Part 50 App F Sections 1.5.10 and 2.4.10 2) Recommendation 3) 40 CFR Part 50 App F Sections 1.5.10 and 2.4.10 Regulation states ≥96%, 96 – 104% is a recommendation
OPERATIONAL CRITERIA – NO_2			
Shelter Temperature Range	Daily (hourly values)	20 to 30°C (Hourly avg) or per manufacturers specifications if designated to a wider temperature range	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2 Generally the 20-30°C range will apply but the most restrictive operable range of the instruments in the shelter may also be used as guidance. FRM/FEM list found on AMTIC provides temp. range for given instrument. FRM/FEM monitor testing is required at 20-30°C range per 40 CFR Part 53.32
Shelter Temperature Control	Daily (hourly values)	≤ ±2°C Standard Deviation (SD) over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/6 mo.	±2°C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	***Every site 1/year 25% of sites quarterly***	Percent difference of audit levels 3-10 < ±15% Audit levels 1&2 ±1.5 ppb difference or ±15%	1) 40 CFR Part 58 App A Section 3.2.2 2) 40 CFR Part 58 App A Section 3.2.2 3) Recommendation - 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html

Table 7. NO_X Collection Measurement and Data Quality Objectives (Continued)

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information/Action
OPERATIONAL CRITERIA – NO_2			
Verification/Calibration	Upon receipt/ adjustment/repair/ installation/moving 1/6 months if manual zero/span performed biweekly 1/year if continuous zero/span performed daily	Instrument residence time ≤2 min Dynamic parameter ≥2.75 ppm-min All points within ±2% of calibration range of best-fit straight line	1) 40 CFR Part 50 App F 2 and 3) Recommendation Multi-point calibration (0 and 4 upscale points)
Gaseous Standards	All gas cylinders	NIST-Traceable (National Institute of Standards and Technology) (e.g., EPA Protocol Gas) 50-100 ppm of NO in Nitrogen with < 1ppm NO_2	1) 40 CFR Part 50 App F Section 1.3.1 2) NA Green Book 3) 40 CFR Part 50 App F Section 1.3.1 Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program 40 CFR Part 58 App A Section 2.6.1
Zero Air/Zero Air Check	1/Year	Concentrations below lower detection limit (LDL)	1) 40 CFR Part 50 App F Section 1.3.2 2 and 3) Recommendation
Gas Dilution Systems	1/year or after failure of 1 point QC check or performance evaluation	Accuracy ±2%	1, 2 and 3) Recommendation based on SO_2 requirement in 40 CFR Part 50 App A-1 Section 4.1.2
Detection (FEM/FRMs)			
Noise	NA	0.005 ppm	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) NA 3) 40 CFR Part 53.20 Table B-1
Lower Detectable Level	1/Year	0.01 ppm	1) 40 CFR Part 53.23 (c) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1

Table 7. NO_2 Collection Measurement and Data Quality Objectives (Continued)

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information/Action
SYSTEMATIC CRITERIA – NO_2			
Sampler/Monitor	NA	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Standard Reporting Units	***All Data***	***ppb (final units in AQS)***	1, 2 and 3) 40 CFR Part 50 App S Section 2 (c)
Rounding Convention for Data Reported to AQS	***All Data***	***1 place after decimal with digits to right truncated***	1, 2 and 3) 40 CFR Part 50 App S Section 4.2 (a)
Completeness	***Annual Standard***	***≥75% hours in year***	1) 40 CFR Part 50 App S Section 3.1(b) 2) 40 CFR Part 50 App S Section 3.1(a) 3) 40 CFR Part 50 App S Section 3.1(b)
	1-Hour Standard	***1) 3 consecutive calendar years of complete data*** ***2) 4 quarters complete in each year*** ***3) ≥75% sampling days in quarter*** ***4) ≥75% of hours in a day***	1) 40 CFR Part 50 App S Section 3.2(b) 2) 40 CFR Part 50 App S Section 3.2(a) 3) 40 CFR Part 50 App S Section 3.2(b) More details in 40 CFR Part 50 App S
Sample Residence Time Verification	1/Year	***< 20 seconds***	1) 40 CFR Part 58 App E, Section 9 (c) 2) Recommendation 3) 40 CFR Part 58 App E, Section 9 (c)
Sample Probe, Inlet, Sampling Train	***All Sites***	***Borosilicate glass (e.g., Pyrex®) or Teflon®***	1, 2 and 3) 40 CFR Part 58 App E Section 9 (a) FEP and PFA have been accepted as equivalent material to Teflon. Replacement or cleaning is suggested as 1/year and more frequent if pollutant load or contamination dictate

Table 7. NO_2 Collection Measurement and Data Quality Objectives (Continued)

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information/Action
SYSTEMATIC CRITERIA – NO_2			
Siting	1/Year	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, Sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E, Sections 2-6
Precision (Using 1-Point QC Checks)	***Calculated annually and as appropriate for design value estimates***	***90% CL CV ≤15%***	1) 40 CFR Part 58 App A Sections 2.3.1.5 & 3.2.1 2) 40 CFR Part 58 App A Section 4 (b) 3) 40 CFR Part 58 App A Section 4.1.2
Bias (Using 1-Point QC Checks)	***Calculated annually and as appropriate for design value estimates***	***95% CL CV ≤ ±15%***	1) 40 CFR Part 58 App A Sections 2.3.1.5 & 3.2.1 2) 40 CFR Part 58 App A Section 4 (b) 3) 40 CFR Part 58 App A Section 4.1.3

Table 8. O_3 Collection Measurement and Data Quality Objectives

1) Requirement (Ozone)	2) Frequency	3) Acceptance Criteria	Information/Action
CRITICAL CRITERIA – Ozone			
1-Point QC Check Single Analyzer	***1/2 weeks***	≤ ±7% (percent difference)	1 and 2) 40 CFR Part 58 App A Section 3.2 3) Recommendation based on DQO in 40 CFR Part 58 App A Section 2.3.1.2. QC Check Conc. range 0.01 - 0.10 ppm, relative to routine concentrations
Zero/span check	1/2 weeks	Zero drift ≤ ±3.0 ppb (24 hr) ≤ ±5.0 ppb (>24hr-14 day) Span drift ≤ ±7%	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO
OPERATIONAL CRITERIA – Ozone			
Shelter Temperature Range	Daily (hourly values)	20 to 30°C (Hourly avg.) or per manufacturers specifications if designated to a wider temperature range	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2 Generally the 20-30°C range will apply but the most restrictive operable range of the instruments in the shelter may also be used as guidance. FRM/FEM list found on AMTIC provides temp. range for given instrument. FRM/FEM monitor testing is required at 20-30°C range per 40 CFR Part 53.32
Shelter Temperature Control	Daily (hourly values)	≤ ±2°C SD over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/6 mo.	±2°C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	***Every site 1/year within period of monitor operation, 25% of sites quarterly***	Percent difference of audit levels 3-10 ≤ ±15% Audit levels 1&2 ±1.5 ppb difference or **±15%**	1 and 2) 40 CFR Part 58 App A Section 3.2.2 3) Recommendation: 3-audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html

Table 8. O_3 Collection Measurement and Data Quality Objectives (Continued)

1) Requirement (Ozone)	2) Frequency	3) Acceptance Criteria	Information/Action
OPERATIONAL CRITERIA – Ozone			
Verification/Calibration	Upon receipt/adjustment/ repair/installation/ moving and repair and recalibration of standard of higher level 1/6 months if manual zero/span performed biweekly 1/year if continuous zero/span performed daily	All points within ± 2%of calibration range of best-fit straight line Linearity error < 5%	1) 40 CFR Part 50 App D 2) Recommendation 3) Recommendation- Linearity error 40 CFR Part 50 App D Multi-point calibration (0 and 4 upscale points) 40 CFR Part 50 App D Section 5.2.3
Zero Air/Zero Air Check	1/Year	Concentration below LDL	1) 40 CFR Part 50 App D Section 4.1 2 and 3) Recommendation
Ozone Level 2 Standard			
Certification/ Recertification to Standard Reference Photometer (Level 1)	1/Year	Single point difference ≤ ±3%	1) 40 CFR Part 50 App D Section 5.4 2 and 3) Transfer Standard Guidance EPA-454/B-10-001 Level 2 standard (formerly called primary standard) usually transported to EPA Regions SRP for comparison
Level 2 and Greater Transfer Standard Precision	1/Year	Standard Deviation less than 0.005 ppm or 3%, whichever is greater	1) 40 CFR Part 50 Appendix D Section 3.1 2) Recommendation, part of reverification 3) 40 CFR Part 50 Appendix D Section 3.1
(if recertified via a transfer standard)	1/Year	Regression slopes = 1.00 ± 0.03 and two intercepts are 0 ± 3 ppb	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001

Table 8. O_3 Collection Measurement and Data Quality Objectives (Continued)

1) Requirement (Ozone)	2) Frequency	3) Acceptance Criteria	Information/Action
OPERATIONAL CRITERIA – Ozone			
Ozone Transfer Standard (Level 3 and Greater)			
Qualification	Upon receipt of transfer standard	±4% or ±4 ppb (whichever greater)	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001
Certification	After qualification and upon receipt/adjustment/repair	Relative Standard Deviation (RSD) of six slopes ≤ 3.7% SD of 6 intercepts 1.5	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001
Recertification to Higher Level Standard	Beginning and end of O_3 season or 1/6 months, whichever less	New slope = ±0.05 of previous and RSD of six slopes ≤ 3.7% SD of 6 intercepts 1.5	1, 2 and 3) Transfer Standard Guidance EPA-545/B-10-001 recertification test that then gets added to most recent 5 tests. If does not meet acceptability certification fails
Detection (FEM/FRMs)			
Noise	Upon receipt/adjustment/repair/installation/moving and repair and recalibration or 1/year	***≤ 0.005 ppm***	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) NA 3) 40 CFR Part 53.20 Table B-1
Lower Detectable Level	1/Year	0.01 ppm	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1
SYSTEMATIC CRITERIA – Ozone			
Sampler/Monitor/ Transfer and Calibration Standard	N/A	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Standard Reporting Units	***All Data***	***ppm (final units in AQS)***	1, 2 and 3) 40 CFR Part 50 App I Section 2.1.1
Rounding Convention for Data Reported to AQS	***All Data***	***3 places after decimal with digits to right truncated***	1, 2 and 3) 40 CFR Part 50 App I Section 2.1.1

Table 8. O_3 Collection Measurement and Data Quality Objectives (Continued)

1) Requirement (Ozone)	2) Frequency	3) Acceptance Criteria	Information/Action
SYSTEMATIC CRITERIA – Ozone			
Completeness (seasonal)	*3-Year Comparison*	***≥ 90% (avg) daily max available in ozone season with min of 75% in any one year***	1) 40 CFR Part 50 App I 2) 40 CFR Part 50 App I Section 2.3 3) 40 CFR Part 50 App I Section 2.3 (b)
	8-Hour Average	***≥ 75% of hourly averages for the 8-hour***	1) 40 CFR Part 50 App I 2 and 3) 40 CFR Part 50 App I Section 2.1.1
	Valid Daily Max	***≥ 75% of the 24, 8-hour averages (18 of 24 8-hour averages)***	1) 40 CFR Part 50 App I 2) 40 CFR Part 50 App I Section 2.1.2 3) 40 CFR Part 50 App I Section 2.1.2 (b)
Sample Residence Time Verification	1/Year	***< 20 seconds***	1) 40 CFR Part 58 App E Section 9 (c) 2) Recommendation 3) 40 CFR Part 58 App E Section 9 (c)
Sample Probe, Inlet, Sampling Train	*All Sites*	***Borosilicate glass (e.g., Pyrex®) or Teflon®***	1) 40 CFR Part 58 App E Section 9 (a) 2) Recommendation 3) 40 CFR Part 58 App E Section 9 (a) FEP and PFA have been accepted as an equivalent material to Teflon. Replacement or cleaning is suggested as 1/year and more frequent if pollutant load or contamination dictate
Siting	1/Year	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E Sections 2-6 2) Recommendation 3) 40 CFR Part 58 App E Sections 2-6
EPA Standard Ozone Reference Photometer (SRP) Recertification (Level 1)	1/Year	Regression slope = 1.00 ±0.01 and intercept < 3 ppb	1,2 and 3) Transfer Standard Guidance EPA-454/B-10-001 This is usually at a Regional Office and is compared against the traveling SRP

Table 8. O_3 Collection Measurement and Data Quality Objectives (Continued)

1) Requirement (Ozone)	2) Frequency	3) Acceptance Criteria	Information/Action
SYSTEMATIC CRITERIA – Ozone			
Precision (Using 1-Point QC Checks)	*Calculated annually and as appropriate for design value estimates*	*90% CL CV ≤ 7%*	1) 40 CFR Part 58 App A 2.3.1.2 & 3.2.1 2) 40 CFR Part 58 App A Section 4 (b) 3) 40 CFR Part 58 App A Section 4.1.2
Bias (Using One-Point QC Checks)	*Calculated annually and as appropriate for design value estimates*	*95% CL ≤ ±7%*	1) 40 CFR Part 58 App A 2.3.1.2 & 3.2.1 2) 40 CFR Part 58 App A Section 4 (b) 3) 40 CFR Part 58 App A Section 4.1.3

Table 9. SO_2 Collection Measurement and Data Quality Objectives

1) Requirement (SO_2)	2) Frequency	3) Acceptance Criteria	Information/Action
CRITICAL CRITERIA – SO_2			
1-Point QC Check Single Analyzer	***1/2 weeks***	≤ ±10% (percent difference)	1 and 2) 40 CFR Part 58 App A Section 3.2 3) Recommendation based on DQO in 40 CFR Part 58 App A Section 2.3.1.2 QC Check Conc. range 0.01 - 0.10 ppm Relative to routine concentrations
Zero/Span Check	1/2 weeks	Zero drift ≤ ±3 ppb (24 hr) ≤ ±5 ppb (>24hr-14 day) Span drift ≤ ±10%	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO
1) Requirement (SO_2)	**2) Frequency**	**3) Acceptance Criteria**	**Information/Action**
OPERATIONAL CRITERIA – SO_2			
Shelter Temperature Range	**Daily** (hourly values)	20 to 30°C (Hourly avg.) or per manufacturers specifications if designated to a wider temperature range	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2 Generally the 20-30°C range will apply but the most restrictive operable range of the instruments in the shelter may also be used as guidance. FRM/FEM list found on AMTIC provides temp. range for given instrument. FRM/FEM monitor testing is required at 20-30°C range per 40 CFR Part 53.32
Shelter Temperature Control	Daily (hourly values)	≤ ±2°C SD over 24 hours	1, 2, and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/6 mo.	±2°C of standard	1, 2, and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	***Every site 1/year 25% of sites quarterly***	Percent difference of audit levels 3-10 ≤ ±15% Audit levels 1&2 ±1.5 ppb difference or ±15%	1 and 2) 40 CFR Part 58 App A Section 3.2.2 3) Recommendation - 3 audit concentrations not including zero. AMTIC guidance 2/17/2011 http://www.epa.gov/ttn/amtic/cpreldoc.html

Table 9. SO_2 Collection Measurement and Data Quality Objectives (Continued)

1) Requirement (SO_2)	2) Frequency	3) Acceptance Criteria	Information/Action
OPERATIONAL CRITERIA – SO_2			
Verification/Calibration	Upon receipt/adjustment/ repair/installation/moving 1/6 months if manual zero/span performed biweekly 1/year if continuous zero/span performed daily	All points within ±2% of calibration of best-fit straight line	1) 40 CFR Part 50 App A-1 Section 4 2 and 3) Recommendation Multi-point calibration (0 and 4 upscale points)
Gaseous Standards	***All gas cylinders***	***NIST-Traceable (e.g., EPA Protocol Gas)***	1) 40 CFR Part 50 App A-1 Section 4.1.6.1 2) NA Green Book 3) 40 CFR Part 50 App F Section 1.3.1 Producers must participate in Ambient Air Protocol Gas Verification Program 40 CFR Part 58 App A Section 2.6.1
Zero Air/ Zero Air Check	1/Year	Concentrations below LDL < 0.1 ppm aromatic hydrocarbons	1) 40 CFR Part 50 App A-1 Section 4.1.6.2 2) Recommendation 3) Recommendation and 40 CFR Part 50 App A-1 Section 4.1.6.2
Gas Dilution Systems	1/year or after failure of 1-point QC check or performance evaluation	***Accuracy ±2%***	1) 40 CFR Part 50 App A-1 Section 4.1.2 2) Recommendation 3) 40 CFR Part 50 App A-1 Section 4.1.2
Detection (FEM/FRMs)			
Noise	NA	***0.001 ppm (standard range)*** ***0.0005 ppm (lower range)***	1) 40 CFR Part 53.23 (b) (definition & procedure) 2) NA 3) 40 CFR Part 53.20 Table B-1
Lower Detectable Level	1/Year	***0.002 ppm (standard range)*** ***0.001 ppm (lower range)***	1) 40 CFR Part 53.23 (c) (definition & procedure) 2) Recommendation 3) 40 CFR Part 53.20 Table B-1

Table 9. SO_2 Collection Measurement and Data Quality Objectives (Continued)

1) Requirement (SO_2)	2) Frequency	3) Acceptance Criteria	Information/Action
SYSTEMATIC CRITERIA – SO_2			
Sampler/Monitor	***NA***	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58 App C Section 2.1 2) NA 3) 40 CFR Part 53 & FRM/FEM method list
Standard Reporting Units	***All Data***	***Ppb (final units in AQS)***	1, 2 and 3) 40 CFR Part 50 App T Section 2 (c)
Rounding Convention for Data Reported to AQS	***All Data***	***1 place after decimal with digits to right truncated***	1, 2 and 3) 40 CFR Part 50 App T Section 2 (c)
Completeness (Seasonal)	***1-Hour Standard***	***Hour – 75% of hour Day – 75% hourly Conc. Quarter – 75% complete days Years – 4 complete quarters 5-min. value reported only for valid hours***	1, 2, and 3) 40 CFR Part 50 App T Section 3 (b), (c) More details in CFR on acceptable completeness. 5-min. values or 5-min. max. value only reported for the valid portion of the hour reported. If the hour is incomplete no 5-min. or 5-min. max reported
Sample Residence Time Verification	1/Year	***< 20 seconds***	1) 40 CFR Part 58 App E Section 9 (c) 2) Recommendation 3) 40 CFR Part 58 App E Section 9 (c)
Sample Probe, Inlet, Sampling Train	***All Sites***	***Borosilicate glass (e.g., Pyrex®) or Teflon®***	1, 2, and 3) 40 CFR Part 58 App E Section 9 (a) FEP and PFA have been accepted as equivalent material to Teflon. Replacement or cleaning is suggested as 1/year and more frequent if pollutant load or contamination dictate
Siting	1/Year	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58 App E, Sections 2-5 2) Recommendation 3) 40 CFR Part 58 App E, Sections 2-5
Precision (Using 1-Point QC Checks)	***Calculated annually and as appropriate for design value estimates***	***90% CL CV ≤ 10%***	1) 40 CFR Part 58 App A Sections 2.3.1.6 & 3.2.1 2) 40 CFR Part 58 App A Section 4 (b) 3) 40 CFR Part 58 App A Section 4.1.2
Bias (Using One-Point QC Checks)	***Calculated annually and as appropriate for design value estimates***	***95% CL ≤ ±10%***	1) 40 CFR Part 58 App A Sections 2.3.1.6 & 3.2.1 2) 40 CFR Part 58 App A Section 4 (b) 3) 40 CFR Part 58 App A Section 4.1.3

Table 10. Continuous PM_{10} Collection Measurement and Data Quality Objectives

1) Criteria (PM_{10} Cont.)	2) Frequency	3) Acceptable Range	Information/Action (CFR or Method 2.11)
CRITICAL CRITERIA – PM_{10} CONTINUOUS			
Sampling Period	Continuous	75% of hourly samples must be valid for valid 24-hour reading	
Sampling Instrument BAM-1020 Equipped with MEDO Pump			
Average Flow Rate (FR)	Every 24 hours of operation	Average within 5% of design	Recommendation
Verification/Calibration			
One-Point FR Verification	1/month	Average within 5% of design	40 CFR Part 58 App A Section 3.2.3
Reference Membrane Verification (BAM)	Hourly	±4% of ABS value	
1) Criteria (PM_{10} Cont.)	**2) Frequency**	**3) Acceptable Range**	**Information/Action (CFR or Method 2.11)**
OPERATIONAL EVALUATIONS TABLE – PM_{10} CONTINUOUS			
Verification/Calibration			
System Leak Check	Every 30 days	< 1.0 liters per minute (lpm)	Method 2.11 Section 2.3.2, BAM-1020 Manual
FR Multi-Point Verification/Calibration	Quarterly	All 3 points within ±4% of design	Method 2.11 Section 2.3.2, BAM-1020 Manual
Audits			
Semi-Annual FR Audit	Quarterly	10% of audit standard design	40 CFR Part 58 App A Section 3.2.4
Monitor Maintenance			
Inlet/Downtube Cleaning	Quarterly	Cleaned	Method 2.11 Section 6, BAM 1020 Manual
Nozzle Cleaning	Monthly or as needed	Cleaned	BAM-1020 Manual
MFGR-Recommended Maintenance	Per MFGR manual	Per MFGR manual	

Table 10. Continuous PM_{10} Collection Measurement and Data Quality Objectives (Continued)

1) Criteria (PM_{10} Cont.)	2) Frequency	3) Acceptable Range	Information/Action (CFR or Method 2.11)
SYSTEMATIC CRITERIA – PM_{10} CONTINUOUS			
Data Completeness	Quarterly	≥ 75%	40 CFR Part 50 App K Section 2.3
Reporting Units	All values	µg/m³ at standard temperature and pressure (STP)	40 CFR Part 50 App K
Rounding Convention			
24-hour, Hourly	Quarterly	Nearest 10 µg/m³ (≥ 5 round up)	40 CFR Part 50 App K Section 1
Verification/Calibration standards and re-certifications – All standards should have multi-point certifications against NIST-traceable standards			
FR Transfer Standard	1/Year	±2% of NIST-traceable SD	40 CFR Part 50 App J Section 1
Field Thermometer	1/Year	±0.5°C resolution, ±0.1°C accuracy	Recommendation
Field Barometer	1/Year	±1 mmHg resolution, ±5 mmHg accuracy	Recommendation
Calibration and Check Standards			
FR Transfer Standard	1/Year	±2% of NIST-traceable SD	Method 2.10 Section 9
Verification/Calibration			
Clock/Timer Verification	Quarterly	1 min/month	Recommendation

Table 11. Continuous $PM_{2.5}$ Collection Measurement and Data Quality Objectives

1) Criteria ($PM_{2.5}$ Cont.)	2) Frequency	3) Acceptable Range	Information/Action (CFR or Method 2.11)
CRITICAL CRITERIA – $PM_{2.5}$ CONTINUOUS, Local Conditions			
Sampling Period 24-hour estimate	Continuous	75% of hourly samples must be valid for valid 24-hour reading	40 CFR Part 50 App L Section 3.3, 40 CFR Part 50 App L Section 7.4.15
Hour Estimate	Every hour	Instrument-dependent	See operator's manual
Sampling Instrument BAM-1020 Equipped with MEDO Pump			
Average FR	Every 24 hours of operation	Average within 5% of 16.67 liters/minute	40 CFR Part 50 App L Section 7.4
Variability in FR	Every 24 hours of operation	CV ≤ 2%	40 CFR Part 50 App L Section 7.4.3.2
Verification/Calibration			
One-Point FR Verification	1/4 weeks	±4% of transfer standard	40 CFR Part 50 App L Section 9.2.5, 40 CFR Part 58 App A Sections 3.2.3 & 3.3.2
Reference Membrane Verification (BAM)	Hourly	±4% of ABS Value	
1) Criteria ($PM_{2.5}$ Cont.)	**2) Frequency**	**3) Acceptable Range**	**Information/Action (CFR or Method 2.11)**
OPERATIONAL CRITERIA – $PM_{2.5}$ CONTINUOUS, Local Conditions			
Verification/Calibration			
Leak Check	Every 30 days	< 1.0 lpm	40 CFR Part 50 App L Section 7.4
Temperature Calibration	Quarterly	±2°C	40 CFR Part 50 App L Section 9.3
Pressure Verification	Quarterly	±10 mmHg	40 CFR Part 50 App L Section 9.3
Other Monitor Calibrations	Per MFGR operating manual	Per MFGR operating manual	
FR Calibration	If multi-point verification failure	±2%	40 CFR Part 50 App L Section 9.2

Table 11. Continuous $PM_{2.5}$ Collection Measurement and Data Quality Objectives (Continued)

1) Criteria ($PM_{2.5}$ Cont.)	2) Frequency	3) Acceptable Range	Information/Action (CFR or Method 2.11)
OPERATIONAL CRITERIA – $PM_{2.5}$ CONTINUOUS, Local Conditions			
Calibration & Check Standards (working standards)			40 CFR Part 58 App A Section 3.3.3
Field Thermometer	1/yr	±0.1°C resolution, ±5 mmHg accuracy	Method 2.12 Sections 4.2 & 6.4
Field Barometer	1/yr	±1 mmHg resolution, ±5 mmHg accuracy	Method 2.12 Sections 4.2 & 6.5
Shelter Temperature			
Temperature Range	Daily (hourly values)	20 to 30°C (Hourly avg.) or per MFGR specifications if designated to a wider temperature range	Generally the 20-30°C range applies, but the most restrictive operable range of the instruments in the shelter may also be used as guidance
Temperature Control	Daily (hourly values)	±2°C SD over 24 hours	
Temperature Device Check	2/year	±2°C	

Table 11. Continuous $PM_{2.5}$ Collection Measurement and Data Quality Objectives (Continued)

1) Criteria ($PM_{2.5}$ Cont.)	2) Frequency	3) Acceptable Range	Information/Action (CFR or Method 2.11)
OPERATIONAL CRITERIA – $PM_{2.5}$ CONTINUOUS, Local Conditions			
Monitor Maintenance			
Virtual Impactor Very Sharp Cut Cyclone	Every 30 days	Cleaned/Changed	Method 2.12 Section 9.2
Inlet Cleaning	Quarterly	Cleaned	Method 2.12 Section 9.3
Filter Chamber Cleaning	Quarterly	Cleaned	Method 2.12 Section 9.3
Circulating Fan Filter Cleaning	Quarterly	Cleaned/Changed	Method 2.12 Section 9.3
Nozzle Cleaning	Monthly or more frequently as needed	Cleaned	BAM-1020 Manual
MFGR-Recommended Maintenance	Per MFGR Manual	Per MFGR Manual	
1) Criteria ($PM_{2.5}$ Cont.)	**2) Frequency**	**3) Acceptable Range**	**Information/Action (CFR or Method 2.11)**
SYSTEMATIC CRITERIA – $PM_{2.5}$ CONTINUOUS, Local Conditions			
Data Completeness	Quarterly	> 75%	40 CFR Part 50 App N Section 4.1 (b) Section 4.2 (a)
Reporting Units		µg/m³ at ambient temp/pressure ($PM_{2.5}$)	40 CFR Part 50.3
Rounding Convention			
Annual 3-yr average	Quarterly	Nearest 0.1 µg/m³ (> 0.05 round up)	40 CFR Part 50 App N Section 2.3
24-hour, 3-year average	Quarterly	Nearest 1 µg/m³ (> 0.5 round up)	40 CFR Part 50 App N Section 2.3
Detection Limit			
Lower DL	Hourly	≤ 3.6 µg/m³	BAM-1020 Spec Sheet
Upper Conc. Limit	Hourly	10,000 mg/m³ (milligrams per cubic meter)	BAM-1020 Spec Sheet
FR Transfer Std.	1/yr	±2% of NIST-Traceable Std.	40 CFR Part 50 App L Sections 9.1 & 9.2
Field Thermometer	1/yr	±0.1°C resolution, ±0.5°C accuracy	Method 2.12 Section 4.2.2
Field Barometer	1/yr	±1 mmHg resolution, ±5 mmHg accuracy	Method 2.12 Section 4.2.2

Table 11. Continuous $PM_{2.5}$ Collection Measurement and Data Quality Objectives (Continued)

1) Criteria ($PM_{2.5}$ Cont.)	2) Frequency	3) Acceptable Range	Information/Action (CFR or Method 2.11)
SYSTEMATIC CRITERIA – $PM_{2.5}$ CONTINUOUS, Local Conditions			
Calibration & Check Standards			
FR Transfer Std.	1/yr	±2% of NIST-Traceable Std.	40 CFR Part 50 App L Sections 9.1 & 9.2
Verification/Calibration			
Clock/Timer Verification	Quarterly	1 min/mo**	40 CFR Part 50 App L Section 7.4

1/ Value must be flagged due to current implementation of BAM (sampling 42 minutes/hour): only 1,008 minutes of sampling in 24-hour period

* = Not defined in CFR

@ = Scheduled to occur immediately after impactor cleaned/changed

** = Must ensure that data system stamps appropriate time period with reported sample value

Table 12. Meteorological Collection Measurement and Data Quality Objectives

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
CRITICAL CRITERIA – Meteorological Parameters							
Ambient Temperature	Thermistor	°C	-30 – 50	0.1	Hourly	15 minutes	90%
Vertical Temperature Difference (Delta T)	Thermistor	°C	-3 – 7	0.1	Hourly	15 minutes	90%
Relative Humidity (RH)	Psychrometer/Hygrometer	%	0 – 100	0.5	Hourly	15 minutes	90%
Barometric Pressure (BP)	Aneroid Barometer	mmHg	600 – 1,100	0.5	Hourly	15 minutes	90%
Wind Speed	Cup or Sonic Anemometer	m/s	0.5 – 50	0.25	Hourly	15 minutes	90%
Wind Direction	Vane or Sonic Anemometer	Degrees	0 – 360	1	Hourly	15 minutes	90%
Solar Radiation	Pyranometer	Watts/m^2	0 – 1,300	10	Hourly	15 minutes	90%
Precipitation	Tipping Bucket	Inches/hour	0 – 50	0.001 Inches/day	Hourly	15 minutes	90%
Visual QC Checks	**Acceptance Range**			**Frequency**		**Reference**	
OPERATIONAL EVALUATION TABLE – Meteorological Parameters							
Site Checks	Verify local conditions as compared to sensor disposition			Weekly		QA Handbook Vol. IV	
Audits All Met Parameters	Meet requirements in QA Handbook Vol. IV			Every 6 months		QA Handbook Vol. IV	
Calibrations All Met Parameters	Meet requirements in QA Handbook Vol. IV			Every 6 months		QA Handbook Vol. IV	

Table 13. Upper-Air Collection Measurement and Data Quality Objectives

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
CRITICAL CRITERIA – Upper-Air Parameters							
u, v, w	SoDAR DAS Calculations	m/s			Hourly	15 minutes	90%
Wind Speed	SoDAR	m/s	0 to 45 m/s	0.5	Hourly	15 minutes	90%
Wind Direction	SoDAR	Degrees	0 to 360	1	Hourly	15 minutes	90%
RECOMMENDED AUDIT CRITERIA TABLE – Upper-Air Parameters							
Visual QC Checks	**Suggested Range**			**Frequency**		**Reference**	
Site Checks	Verify local conditions as compared to SoDAR disposition			Weekly		QA Handbook Vol. IV	
Systematic Difference	u,v: ± 1 m/s WS: ± 1 m/s WD: ± 10 °			Within 30 days of the start-up Every 6 months		QA Handbook Vol. IV	
Comparability	u,v: ± 2 m/s WS: ± 2 m/s WD: ± 30 °			Every 3 months		QA Handbook Vol. IV	

A.8 Special Training Needs/Certification

The NO_X, O_3, SO_2, particulate samplers, upper-air, and meteorological instrumentation are operated under the guidance of the Project Manager and Project Data and Field Technician who have extensive experience with this equipment. Any non-routine work on these stations must be conducted by a qualified technician who has more than two years of experience with these sampling systems.

Site Operators for this project receive training on the operation and maintenance of the sampling systems and related equipment. Training is conducted by the Project Manager or his/her designees.

A.9 Documents and Records

Documentation and records for this project typically include, but are not limited to:

- QA plan and revisions
- Certifications of calibration equipment and standards
- Standard Operating Procedures (SOPs)
- Site logbooks or journal entries
- Site check forms
- Copies of maintenance records
- Calibration and audit reports
- Quarterly reports
- Raw data files

Copies of all the forms used to document the system performance and data custody can be found in Appendix A.

A.9.1 Data Reporting Package Format and Documentation Control

The Project Manager submits quarterly summary data reports to the Program Director within 90 days of the conclusion of each quarter of the monitoring program. Each quarterly report contains the following:

- The number of possible observations for the quarter, the number of actual valid observations for the quarter, and the data completeness (percent) for the quarter with an explanation of any instrument malfunction for each parameter
- All valid hourly meteorological and upper-air data collected during the quarter laid out in a monthly matrix

- Graphical summaries of the monthly averages and the means and extremes for the meteorological parameters
- Summaries of the concentrations for hourly values and applicable averaging periods for NO_X, O_3, SO_2, PM_{10}, and $PM_{2.5}$ with discussions of maximum recorded values and supplemental information on any recorded valid concentrations that are worthy of further discussion
- Hourly NO_X, O_3, SO_2, PM_{10}, and $PM_{2.5}$ data presented in a monthly matrix
- Copies of any calibrations and audits performed during the quarter
- Copies of all verifications and site check forms performed during the quarter

A.9.2 Data Reporting Package Archiving and Retrieval

The data are stored on Air Sciences' server and then processed into quarterly reports. At that time the data are transferred, in triplicate, to optical discs. The optical discs are stored in a climate-controlled environment at Air Sciences' offices and at a location off-site. Data-storage devices (fire-proof hard drives) are swapped out every other week to assure a secondary backup location. Data retrieval is conducted at the request of the Program Director or PCAQCD. Air Sciences stores project data for a minimum of five years after collection.

A.9.3 Monitoring Plan Distribution

Within 30 days of approval and full signature completion of the monitoring plan and its subsequent revisions, the document will be distributed by the Program Director to all signatories.

B. DATA GENERATION AND ACQUISITION

B.1 Sampling Process Design and Methods Requirements

B.1.1 Purpose

The Resolution Project monitoring system is designed to provide meteorological (wind speed, wind direction, sigma theta, air temperature, air temperature differential, solar radiation, relative humidity, barometric pressure, and precipitation), upper-air, NO_X, O_3, SO_2, PM_{10}, and $PM_{2.5}$ concentration data in support of air permit applications and for other environmental purposes. The system design includes several air quality and meteorological monitoring stations in the network. This document describes the plan for these stations.

B.1.2 Monitoring Site Locations

The monitoring program identified in this document describes the air quality and meteorological monitoring efforts and requirements at four stations in areas of potential emission sources for RCML facilities: the East and West Plant monitoring stations, the Hewitt monitoring station, and the Far West monitoring station.

The East and West Plant sites are supplemented with data collected from the Hewitt Station and eventually from Far West monitoring site. The Hewitt Station was deployed in October 2014 and data collection began January 1, 2015. The Far West site was deployed in March 2016 and data collection began April 1, 2016. The monitoring stations and their distances from the town of Superior can be seen in Table 14.

The East Plant site is located approximately two miles east of Superior, where future underground mining and ore processing and conveying will take place. This station collects meteorological data, particulate data, and air pollutants (PM_{10}, $PM_{2.5}$, and O_3, NO_X, and SO_2) representative of that area and suitable as input to the AERMOD modeling system. This site is representative of the Pinto Valley region and has available power.

The West Plant site is located near the base of elevated terrain in the relatively flat region just north of Superior. This station includes monitoring of meteorological parameters and particulate data (PM_{10} and $PM_{2.5}$). This station was selected due to its representativeness of a location that is central to the Resolution Project's operations and local population and its proximity to available power.

The Hewitt Station, located approximately six miles west of Superior, includes meteorological and upper-air monitoring. This station collects meteorological data using SoDAR technology and an adjacent 20-meter tower. The SoDAR is located approximately 200 feet northwest of the meteorological monitoring tower.

The Far West site will monitor meteorological parameters as well as particulate matter (PM_{10} and $PM_{2.5}$). This site is approximately 16 miles southwest of the town of Superior. Selection of this location was based on its representativeness of meteorological conditions that could influence dust emissions from the tailings disposal area of the Resolution Project. Another goal of the monitoring program at this site is to establish existing ("background") concentrations of particulate matter in the area proximate to the location of this potential project emissions source.

Table 14. Monitoring Stations Summary

Station	Approximate Location	Type of Monitoring Station
East Plant	2 Miles East of Superior	Meteorological and Air Quality
West Plant	Northern Edge of Superior	Meteorological and Air Quality
Hewitt Station	6 Miles West of Superior	Meteorological and Upper-Air
Far West	16 Miles Southwest of Superior	Meteorological and Air Quality

B.1.3 Monitoring Scales

Each monitoring site at RCC is designed for use as a special purpose monitor. Scale applicability as it relates to State and Local Air Monitoring Stations (SLAMS), Photochemical Assessment Monitoring Stations (PAMS), and other monitoring networks is not entirely relevant to this program. With input from PCAQCD, the language in 40 CFR Part 58 Appendix D was used for the RCML program to help identify the most suitable scaling definition for each monitoring station (listed in Table 15). The site locations were selected, and then scales that applied to the locale and purpose were chosen as a best fit, as opposed to the intended order outlined in 40 CFR Appendix D, where scale drives monitor location selection.

The monitoring scales applied to all four sites relate to the monitoring site type of "background and regional transport," assigning the regional scale as the most applicable to the sites.[3] Regional scale is defined in 40 CFR Part 58, Appendix D, Section 1.2, as "a rural area of reasonably homogenous geography without large sources, and extends from tens to hundreds of kilometers." This description aligns the spatial scale with the project goals, which focus on baseline monitoring. Baseline monitoring goals are associated with the appropriate "regional scale" again in Table D-1 of 40 CFR Part 58, Appendix D.

[3] Throughout the monitoring program, RCML will be conducting remediation, pre-development, and development activities proximate to the monitoring stations. These activities will produce dust and combustion emissions. As a routine aspect of the monitoring data QA/QC review, Air Sciences and RCML will investigate elevated pollutant concentrations and assess (qualitatively and/or quantitatively) the likelihood that monitored concentrations were influenced by local, RCML, or other unusual, intermittent sources. Remediation, pre-development, and development activities will not occur during normal mining operations.

Table 15. Scale Applicability as Related to the Monitoring Stations

Station	Monitored Air Pollutants	Purpose	Scale(s)	Key Words
East Plant	PM_{10}, $PM_{2.5}$, O_3, NO_X, SO_2	Baseline	Regional	Rural area of reasonably homogenous geography without large sources, and extends from tens to hundreds of kilometers (40 CFR Part 58, Appendix D, Section 1.2)
West Plant	PM_{10}, $PM_{2.5}$	Baseline	Regional	Rural area of reasonably homogenous geography without large sources, and extends from tens to hundreds of kilometers (40 CFR Part 58, Appendix D, Section 1.2)
Hewitt Station	Upper-Air Meteorology	Baseline	Regional	Rural area of reasonably homogenous geography without large sources, and extends from tens to hundreds of kilometers (40 CFR Part 58, Appendix D, Section 1.2)
Far West	PM_{10}, $PM_{2.5}$	Baseline	Regional	Rural area of reasonably homogenous geography without large sources, and extends from tens to hundreds of kilometers (40 CFR Part 58, Appendix D, Section 1.2)

Figure 12 through Figure 21 are panoramic (180-degree) photos that show the nearby obstructions, topography, and vegetation at the sites.

Figure 12. East Plant Station, Facing East

Figure 13. East Plant Station, Facing West

Figure 14. West Plant Station, Facing East

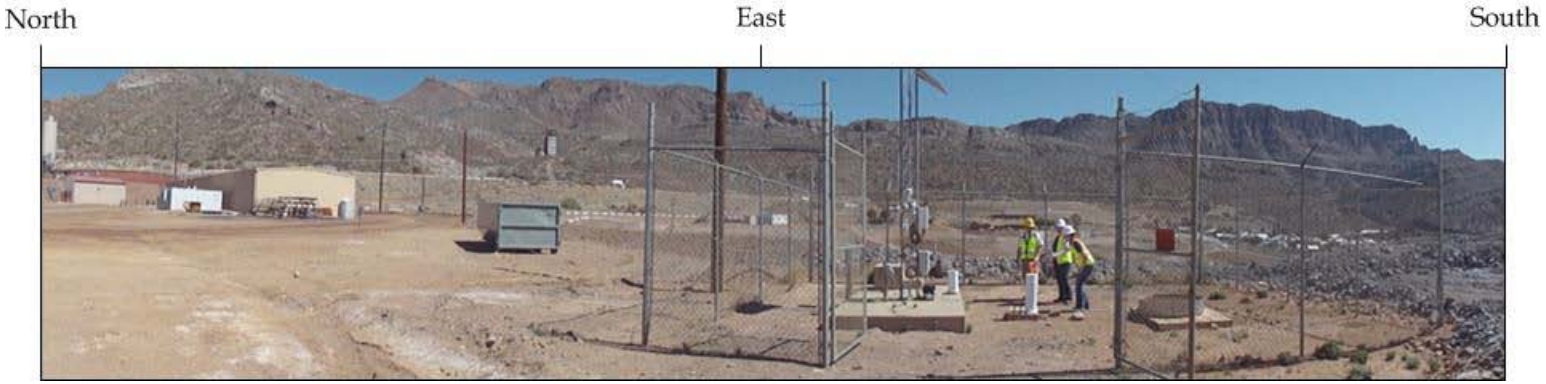


Figure 15. West Plant Station, Facing West

Figure 16. Hewitt Station SoDAR, Facing East

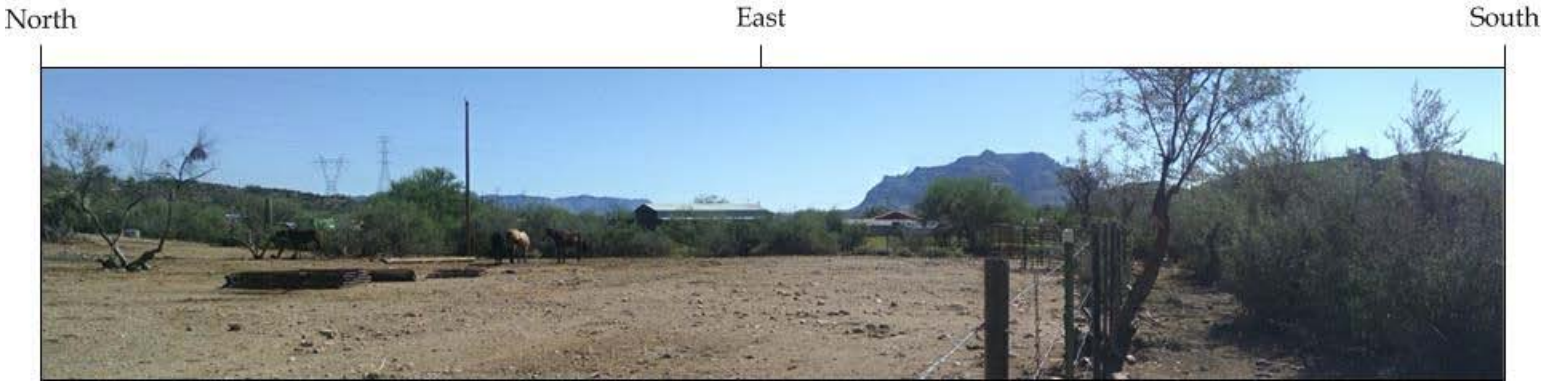


Figure 17. Hewitt Station SoDAR, Facing West

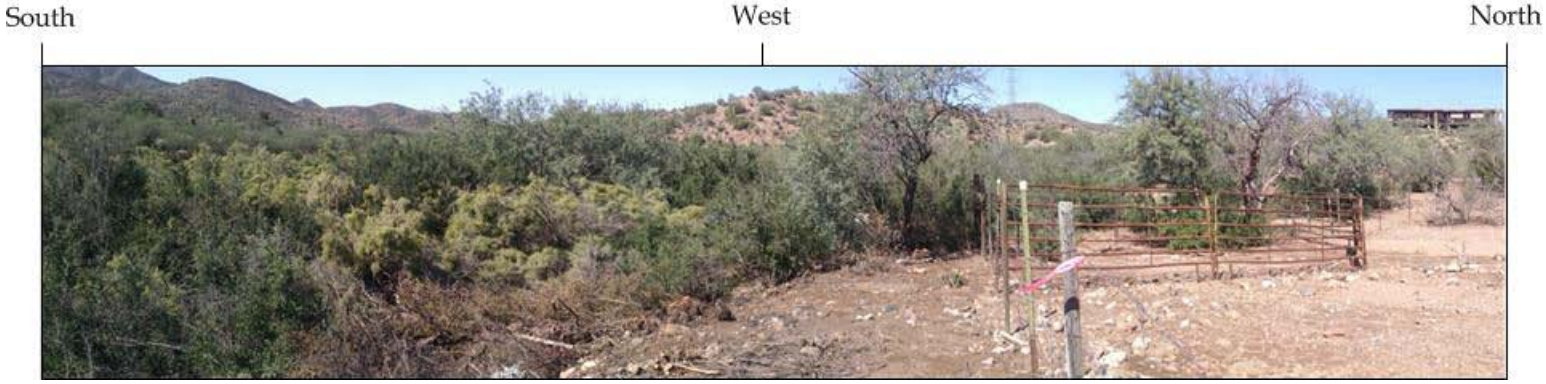


Figure 18. Hewitt Station 20-Meter Tower, Facing East

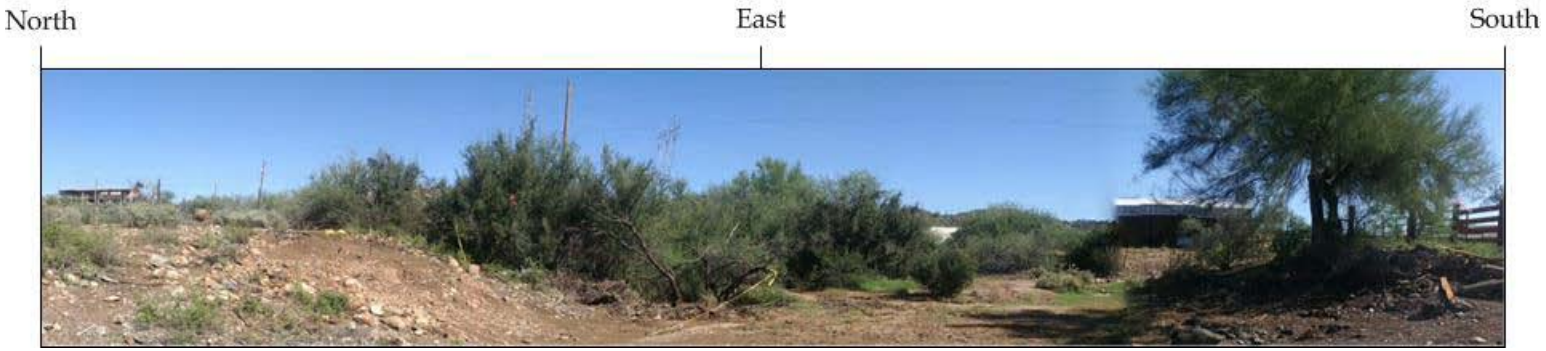


Figure 19. Hewitt Station 20-Meter Tower, Facing West

Figure 20. Far West Station, Facing East

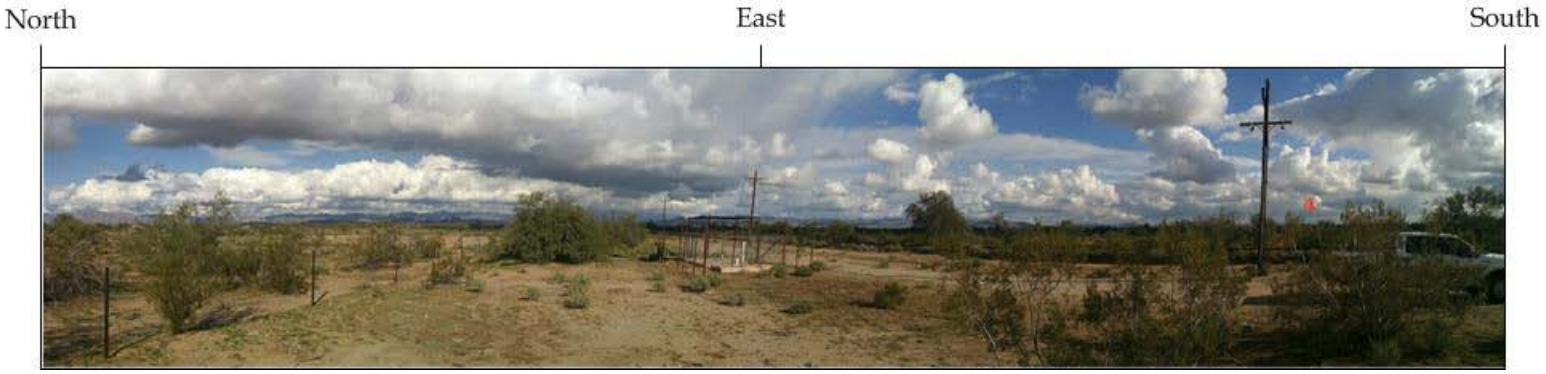
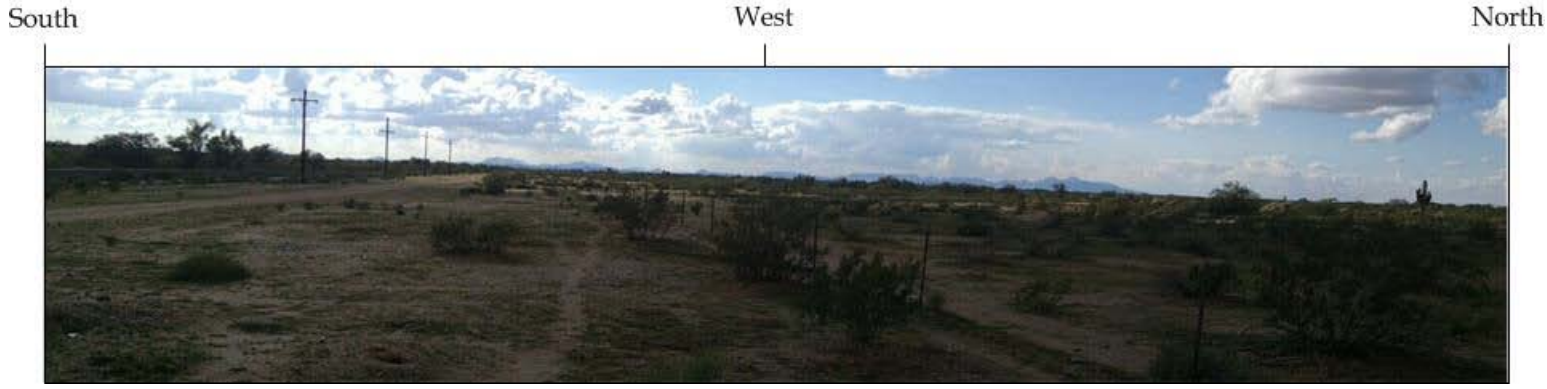


Figure 21. Far West Station, Facing West



B.2 Sampling Methods

Sampling of meteorological and ambient air concentrations is performed using appropriate monitoring methods to assure representative samples. The following sections cover the methods that are used in this program, instrument installation, and the operational environment.

The monitoring methods employed for the Resolution Mine Ambient Air and Meteorological Monitoring Program are designated by the EPA as either Automated Reference Methods or Manual Reference Methods, consistent with the *Ambient Monitoring Guidelines for Prevention of Significant Deterioration* (EPA-450/4-87-007).

Continuous analyzers and samplers have been deployed to measure NO_X, O_3, SO_2, PM_{10}, and $PM_{2.5}$. Sensors and dataloggers purchased from Campbell Scientific are used to measure, post-process, and store meteorological data.

The following sections describe these instruments and monitoring methods.

B.2.1 NO_X Monitoring

NO_X is measured using the Teledyne Advanced Pollution Instrumentation (API) Model T200 Chemiluminescence NO_X Analyzer. These analyzers have an EPA equivalency designation as a Reference Method (RFNA-1194-099). Average hourly NO_X values are measured over the duration of one-year (minimum) sampling periods. The instrument is calibrated through the employment of the Teledyne API Model T700 Dynamic Dilution Calibrator. Zero Air is provided using the Teledyne API Model 701 Zero Air System.

The SOP for the T200 Analyzer is provided in Appendix B.

B.2.2 O_3 Monitoring

O_3 is measured using the Teledyne API Model T400 UV Absorption O_3 Analyzer. These analyzers have an EPA equivalency designation as a Reference Method (EQOA-0992-087). Average hourly O_3 values are measured over the duration of one-year (minimum) sampling periods. The instrument is checked by nightly spans by employing the "Level 3" Teledyne API Model T700 Dynamic Dilution Calibrator with the additional photometer transfer standard add-on. Zero Air is provided using the Teledyne API Model 701 Zero Air System.

Quarterly calibrations and verifications are carried out by challenging the Teledyne T400 with a "Level 2" transfer standard, which is certified annually by Teledyne API using instruments calibrated by an independent party using a NIST - traceable Standard Reference Photometer for the assay of ozone in accordance to 40CFR50 ,Appendix D. All documentation is submitted to support this traceability.

The SOP for the T400 Analyzer is provided in Appendix B.

B.2.3 SO_2 Monitoring

SO_2 is measured using the Teledyne API Model T100 UV Fluorescence SO_2 Analyzer. These analyzers have an EPA equivalency designation as a Reference Method (EQSA-0495-100). Average hourly SO_2 values are measured over the duration of one-year (minimum) sampling periods. The instrument is calibrated through the employment of the Teledyne API Model T700 Dynamic Dilution Calibrator. Zero Air is provided using the Teledyne API Model 701 Zero Air System.

The SOP for the T100 Analyzer is provided in Appendix B.

B.2.4 PM_{10} and $PM_{2.5}$ Monitoring

PM_{10} and $PM_{2.5}$ are measured using Met One BAM-1020 continuous particulate monitors. These monitors have an EPA equivalency designation as a reference method (EQPM-0308-170). Average hourly PM_{10} and $PM_{2.5}$ values are measured over the duration of the sampling period. The BAM-1020 monitors use firmware that are capable of internally converting results to standard (temperature and pressure) conditions for PM_{10} output. All $PM_{2.5}$ data are reported in actual (temperature and pressure) conditions.

The SOP for the BAM-1020 monitor is provided in Appendix B.

B.2.5 Meteorological Monitoring

The Campbell Scientific sensors used to monitor horizontal wind speed, horizontal wind direction, sigma theta, ambient temperature, delta temperature, relative humidity, barometric pressure, solar radiation, and precipitation meet the specifications stated in the *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005). These sensors are continuously operated throughout the monitoring program. Spare parts and supplies are available in case they are needed for maintenance or repair.

The sensors are mounted on a 10-meter open-lattice tower at the East Plant, West Plant, and Far West Stations, and on a 20-meter open-lattice tower at the Hewitt Station. The sensor heights are listed in Table 16 and are also shown in Figure 2 and Figure 3. Table 17 and Table 18 list the meteorological sensor accuracy, measurement resolution, and performance specifications.

The SOPs for the meteorological sensors are provided in Appendix B.

The delta temperature probe height selection was based on guidance in EPA-454/R-99-005, Section 3.2.2.1, which says that the temperature difference should be measured at 20 and 100 times the estimated surface roughness length (SRL). The estimated SRL (for the purpose of temperature probe placement) for the monitoring stations was based on visual inspection of the

landscape of all the sites and then selection of an appropriate terrain classification description using EPA-454/R-99-005, Table 6-10. "Low crops, occasional large obstacles" was determined to be an appropriate description of the areas proximate to the monitoring stations. Table 6-10 provides an SRL of 0.10 meters for this terrain classification. An SRL of 0.10 meters results in temperature probe placement heights of 2 meters (20 times SRL) and 10 meters (100 times SRL).

The monthly and directionally-specific SRLs for terrain surrounding the monitoring sites will be determined when the inputs and setup of the AERMOD and AERSURFACE analyses take place. The methodology for AERMOD and AERSURFACE will be included in the modeling protocol to be submitted and approved by PCAQCD.

Table 16. Sensor Heights

Parameter	West Plant	East Plant	Hewitt	Far West
Wind speed	10	10	10, 2	10
Wind direction	10	10	10, 2	10
Ambient temperature	2	2	2	2
Relative humidity	2	2	2	2
Barometric pressure	1	1	1	1
Precipitation	Ground	Ground	--	Ground
Delta temperature	2, 10	2, 10	2, 10	2, 10
Solar radiation	2	2	2	2

B.2.6 Upper-Air Meteorological Monitoring

Upper-air data is acquired through an Atmospheric Systems Corporation SoDAR that meets the *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005) specifications. The SoDAR is continuously operated to collect wind measurements at 10-meter intervals from 20 to 190 meters above the ground for the duration of the program.

Table 17. Meteorological Sensor Accuracy and Measurement Resolution

Parameter	Sensor	Range	Accuracy	Standard	Measurement Resolution	Reference
Wind Direction	R.M. Young 05305	0 to 360 degrees	±3 degrees	Accuracy: ±5 degrees	1.0 degree	EPA-454/B-08-002, March 2008, Table 0-7; EPA-454/R-99-005, February 2000, Table 5-1
Wind Speed	R.M. Young 05305	0.4 to 45 m/s	±0.2 m/s	Accuracy: ±0.2 m/s up to speeds of 5 m/s and +5% thereafter	0.1 m/s	EPA-454/B-08-002, March 2008, Table 0-7; EPA-454/R-99-005, February 2000, Table 5-1
Ambient Temperature	Calibrated R.M. Young 43347 Platinum RTD	-50°C to +50°C	±0.1 degrees	±0.5 degrees	0.1°C	EPA-454/B-08-002, March 2008, Table 0-7; EPA-454/R-99-005, February 2000, Table 5-1
Delta Temperature	Paired, Calibrated R.M. Young 43347 Platinum RTD	-50°C to +50°C	±0.05 degrees	±0.1 degrees	0.02°C	EPA-454/B-08-002, March 2008, Table 0-7; EPA-454/R-99-005, February 2000, Table 5-1
Relative Humidity	Campbell Scientific Model HC2S3	0.8 to 100%	+2% (0 to 90% RH) and +3% (90 to 100% RH)	±1.5°C dew point temperature error	1%	EPA-454/B-08-002, March 2008, Table 0-7; EPA-454/R-99-005, February 2000, Table 5-1
Solar Radiation	Kipp & Zonen CMP3	310–2,800 nanometers	±5%	±5%	10 W/m^2	EPA-454/B-08-002, March 2008, Table 0-7; EPA-454/R-99-005, February 2000, Table 5-1
Barometric Pressure	Vaisala PTB110	500 to 1,100 millibars (mb)	+0.5 to 1.5 mb (temp. depend.)	±3 mb	+0.5 mb	EPA-454/B-08-002, March 2008, Table 0-7; EPA-454/R-99-005, February 2000, Table 5-1
Precipitation	R.M. Young 52202	n/a	2% for up to 1 in. hr-1; 3% for up to 2 in. hr-1	±10% of observed or ±0.5 mm	0.004 inch	EPA-454/B-08-002, March 2008, Table 0-7; EPA-454/R-99-005, February 2000, Table 5-1

Table 18. Meteorological Sensor Specifications

Parameter	Sensor	Parameter	MFGR Specifications	Required Specifications	Reference
Wind Speed	R.M. Young 05305	Starting speed	0.4 m/s	≤0.5 m/s	EPA-454/R-99-005, February 2000, Table 5-2
		Distance constant	2.1 m	≤5 m	EPA-454/R-99-005, February 2000, Table 5-2
Wind Direction	R.M. Young 05305	Starting speed	0.5 m/s	≤0.5 m/s @ 10 degrees	EPA-454/R-99-005, February 2000, Table 5-2
		Damping ratio	0.3	0.4 to 0.7	EPA-454/R-99-005, February 2000, Table 5-2
		Delay distance	1.3 m	≤5 m/s	EPA-454/R-99-005, February 2000, Table 5-2
Ambient Temperature	Calibrated R.M. Young 41342 Platinum RTD	Time constant	42 seconds	≤1 minute	EPA-454/R-99-005, February 2000, Table 5-2
Delta Temperature	Paired, Calibrated R.M. Young 43347 Platinum RTD	Time constant	42 seconds	≤1 minute	EPA-454/R-99-005, February 2000, Table 5-2
Solar Radiation	Kipp & Zonen CMP3	Time constant	10 micro-seconds	5 seconds	EPA-454/R-99-005, February 2000, Table 5-2
Upper-Air Meteorology Speed Direction	ASC SoDAR 4000we	Acoustic pulses	< 0.5 m/s WD ±2 degrees (WS > 2 m/s)		

B.2.7 Environmental Controls

Weatherproof enclosures are installed at all air monitoring sites to assure protection of sensitive components. Each enclosure is equipped with Heating, Ventilation, and Air Conditioning (HVAC) units, which keep all analyzers and monitors within the approved temperature range required by the instrument manufacturers (5° to 40°C). Relative humidity indicator cards are employed to track the level of moisture inside each enclosure. Desiccant packs are installed when necessary to ensure a dry environment.

The SoDAR and all associated components are housed in a trailer-mounted enclosure that is specifically designed to protect all instrumentation from adverse weather conditions. The enclosure and trailer were designed and built by the manufacturer of the SoDAR system.

B.3 Sampling Handling and Custody

B.3.1 Data Custody

Data retrieval, quality control, and processing are documented in the Air Sciences data acquisition storage system (DASS). Site check forms and all other program documentation are stored in two places. Copies are scanned and saved to an electronic project file, and the originals are filed at Air Sciences. All forms are submitted with each quarterly report.

The data are QA'd weekly and stored on the Air Sciences server and backed up on optical disk. Following data reduction, the data remain in the DASS until they are analyzed and summarized for the quarterly reports.

B.4 Analytical Methods

Monitoring is conducted in accordance with the following publications:

- Guidance for Quality Assurance Project Plans (EPA QA/G-5, December 2002)
- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program (EPA-454/B-13-003, May 2013)
- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements (EPA-454/B-08-002, March 2008)
- Transfer Standards for the Calibration of Ambient Air Monitoring Analyzers for Ozone (EPA-454/B-13-004, October 2013)
- Code of Federal Regulations (40 CFR Parts 50 and 58)
- Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD) (EPA-450/4-87-007, May 1987)
- Meteorological Monitoring Guidance for Regulatory Modeling Applications (EPA-454/R-99-005, February 2000)

B.5 Quality Control

The quality control for the program includes site checks every week, along with quarterly sampler audits and calibrations. These guidelines are documented in Table 7 through Table 13.

Multi-point calibrations of the PM_{10}, $PM_{2.5}$, NO_X, SO_2 and O_3 analyzers occurred upon installation, and are now conducted biannually and in the event of malfunction, equipment relocation, or audit failures. Multi-point calibrations are used to assess the linearity of the analyzers.

Multi-point audits of the NO_X, SO_2 and O_3 analyzers are conducted quarterly or as needed. Multi-point audits are used to assess data accuracy and analyzer performance using certified, traceable standards different than those used for QC or calibration operations.

Flow audits are performed on the PM_{10} and $PM_{2.5}$ samplers on a monthly basis.

A summary of the QC checks performed can be found in Table 19.

Table 19. Summary of Ambient Air Monitoring QC Checks

Field Operation Activities	Schedule				
	Biweekly	Each Visit	Monthly	Quarterly	Biannually
Visually inspect all monitoring instrumentation		X			
Record all observations in Onsite Operations Review form and Station Log		X			
Inspect sample line and manifold and replace inline filters if needed			X		
Inspect $PM_{2.5}$ cyclone and clean dust port			X		
Perform analyzer zero and span checks	X	X			
Perform analyzer zero and span precision checks	X				
Perform audits for particulate monitoring instrumentation				O	
Perform multi-point calibrations for NO_X, SO_2 and O_3 analyzers					O
Perform multi-point audits for NO_X, SO_2 and O_3 analyzers				O	
Perform audits for meteorological instrumentation					O

Responsible party:

X – Project Data and Field Technicians and Site Operator

O – QA Auditor

The critical validation criteria tables outline criteria deemed essential to maintaining the validity of the samples. Data not meeting the criteria are either flagged with an explanation or invalidated. The cause for any deviation is investigated and remedied. The critical criteria, operational evaluations, and systematic criteria are listed for each parameter in Section A.7. Air quality and meteorological data outside the screening criteria are flagged or investigated based on the parameters listed in Table 20.

Table 20. Quality Control Screening Criteria

Parameter	Screening Criteria	Action
Gas Analyzers	Span value ±10% of set point for NO_X and SO_2	Investigate data
	Span value ±7% of set point for O_3	Investigate data
	Zero value ≤±3 ppb (24hrs), ≤±5 ppb (> 24hrs - 14days)	Investigate data
PM_{10} and $PM_{2.5}$	Flow is not between 0.792 and 0.876 m^3	Investigate data
	Temperature is less than -50°C or greater than 50°C	Investigate data
	BP is not between 500 and 700 mb	Investigate data
Upper-Air	Is less than zero or greater than 50 m/s	Investigate data
Wind Speed	Does not vary by more than 0.001 m/s	Investigate data
(vector components)	Varies by more than 10 m/s within 1 hour	Investigate data
	Does not vary by more than 1.5 m/s within 8 hours	Investigate data
	Does not vary by more than 2 m/s within 24 hours	Investigate data
	Varies by more than 20 m/s within 24 hours	Investigate data
	Precipitation is recorded at the site	Investigate data
Wind Speed	Is less than zero or greater than 50 m/s	Invalidate data
	Does not vary by more than 0.001 m/s	Investigate data
	Varies by more than 10 m/s within 1 hour	Investigate data
	Does not vary by more than 1.5 m/s within 8 hours	Investigate data
	Does not vary by more than 2 m/s within 24 hours	Investigate data
	Varies by more than 20 m/s within 24 hours	Investigate data
Wind Direction	Is less than zero or greater than 360 degrees	Invalidate data
	Does not vary by more than 1 degree within 1 hour	Investigate data
	Does not vary by more than 10 degrees within 8 hours	Investigate data
Temperature	Is less than -50°C or greater than 50°C	Invalidate data
	Is greater than the local record high	Investigate data
	Is less than the local record low	Investigate data
	Does not vary by more than 0.01°C within 1 hour	Investigate data
	Varies by more than 5°C within 1 hour	Investigate data
	Does not vary by more than 1°C within 8 hours	Investigate data
	Varies by more than 10°C within 8 hours	Investigate data
	Does not vary by more than 4°C within 24 hours	Investigate data
	Varies by more than 20°C within 24 hours	Investigate data
Delta Temperature	Is greater than 1.2°C during the daytime	Investigate data
	Is greater than 6°C or less than –3°C	Investigate data
	Does not vary by more than 0.01°C within 1 hour	Investigate data
	Varies by more than 4°C within 1 hour	Investigate data
	Does not vary by more than 0.01°C within 8 hours	Investigate data
	Varies by more than 4°C within 8 hours	Investigate data
Solar Radiation	Is greater than 1,500 W/m^2	Invalidate data
	Is greater than zero at night	Investigate data
	Does not vary by more than 1 W/m^2 within 1 hour	Investigate data
	Varies by more than 300 W/m^2 within 1 hour	Investigate data
	Does not vary by more than 1 W/m^2 within 8 hours	Investigate data
	Varies by more than 800 W/m^2 within 8 hours	Investigate data
Barometric Pressure	Is greater than 700 mb	Investigate data

Parameter	Screening Criteria	Action
	Is less than 500 mb	Investigate data
Relative Humidity	Is greater than 105%	Investigate data
	Is less than 5%	Investigate data
	Varies by more than 30% within 1 hour	Investigate data
	Does not vary by more than 0.001% within 1 hour	Investigate data
Precipitation	Is greater than 0.5 inch of accumulation within 1 hour	Investigate data
	Is greater than 1 inch of accumulation within 8 hours	Investigate data

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

Before instrumentation deployment, the equipment was visually inspected for damage. After installation and prior to data collection, all sensors and systems were calibrated according to the listed procedures. Site checks are performed every week for the duration of the monitoring period. In addition, routine maintenance procedures are performed according to manufacturer recommendations.

B.6.1 Site Visits

On a weekly basis, at minimum, the Site Operator visits each site and completes the appropriate site check forms. The purpose of these site checks is to visually inspect the station, listen for anomalies in the pumps, and ensure that all systems are operating as expected. In addition to the visual inspection, each QC activity is performed according to the stipulated schedule.

B.6.2 Spare Parts

Spare parts are stored onsite. The spare parts include spare pumps, o-rings, sensor replacements, speakers for the SoDAR, and other consumables such as filter tape and tubing.

B.7 Instrument/Equipment Calibration and Frequency

The instrument calibration and check frequency is listed in the critical, operational, and systematic criteria tables in Section A.7. A NIST-traceable flow meter measures and calibrates flows on the particulate monitors and is certified annually. The gas analyzers are calibrated and span checks are performed using a Teledyne API Model T700 Dynamic Dilution Calibrator. The meteorological equipment calibration frequencies are listed in Table 21.

Table 21. Meteorological Equipment Calibration Frequency

Equipment	Calibration Equipment	Calibration Frequency	Reference
Wind Speed	R.M. Young Model 18802 Anemometer Drive 200 to 15,000 RPM	1/Year	EPA-454/B-08-002/Appx. C
	R.M. Young Model 18820A Control Unit Motor Assembly	1/Year	EPA-454/B-08-002/Appx. C
	R.M. Young Model 18310 Propeller Torque Disc	1/Year	EPA-454/B-08-002/Appx. C
Wind Direction	R.M. Young Model 18212 Vane Angle Fixture – Tower Mount	N/A	EPA-454/B-08-002/Appx. C
	Brunton Transit Compass	N/A	EPA-454/B-08-002/Appx. C
Temperature	VWR Model 61161-382 ASTM –0/+50°C NIST-Traceable Thermometers	1/Year	EPA-454/B-08-002/Appx. C
Delta Temperature	VWR Model 61161-382 ASTM –0/+50°C NIST-Traceable Thermometers	1/Year	EPA-454/B-08-002/Appx. C
Solar Radiation	Collocated NIST-Traceable Pyranometer	1/Year	EPA-454/B-08-002/Appx. C
Relative Humidity	VWR RH Thermo-Hygrometer Pen	1/Year	EPA-454/B-08-002/Appx. C
Barometric Pressure	VWR Model 23609-208 NIST-Traceable BP Sensor	1/Year	EPA-454/B-08-002/Appx. C
Datalogger	Fluke Model 8060A Digital Multimeter	1/Year	N/A

B.8 Inspection/Acceptance of Supplies and Consumables

The primary consumables in this program are the compressed calibration gases for SO_2 and NO_X and the filter tape rolls for the PM_{10} and $PM_{2.5}$ instrumentation.

B.8.1 Particulate Monitoring Filter Tape Inspection

BAM-1020 monitor sampling tape is visually inspected for defects prior to and after the two-month tape-roll life. Upon removal of the tape, the sampling areas are visually inspected for holes or blurry sampling dots, which are all indicators of the need for maintenance.

B.9 Non-Direct Measurements

This project does not require data from non-direct measurement sources.

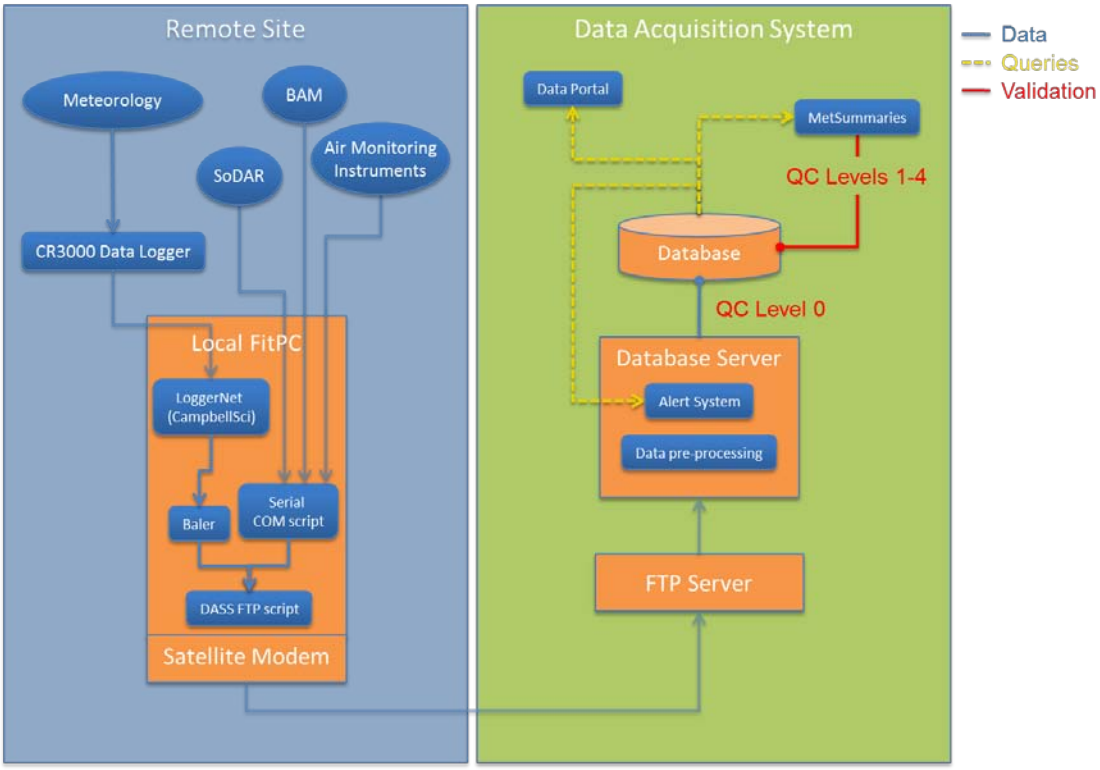
B.10 Data Management

The management of all data associated with this project is critical to assuring the quality of the program. Summaries of the procedures are found in the following sections.

B.10.1 Data Acquisition

The data are automatically downloaded remotely via Verizon Wireless broadband Internet every hour (minimum). Data transfer to Air Sciences' server/database system (DASS) is set up using Campbell Scientific LoggerNet software for the meteorological data, and site-specific file transfer protocol (FTP) data transfer scripts for the SoDAR, SO_2, NO_X, O_3, and particulate instrumentation. Data will be manually collected and processed into the DASS on a weekly basis during periods of cellular communication outages. The data pathways are illustrated in Figure 22.

Figure 22. Data Transfer Flowchart



B.10.2 Data Validation

Raw data files are compared to the site check forms that the Site Operator documents in the field. The instantaneous, one-second datalogger readings recorded by the Site Operator are compared to the 15-minute averages that are logged in the DASS by the Project Data and Field Technicians. Each parameter recorded by the datalogger should be within the tolerances outlined in Table 22 when compared to the reading documented by the Site Operator. If these

tolerances are not met, the data collected prior to and after the data period in question will be investigated. The Site Operator may be requested to visit the site and perform another site check. If a malfunction is found, the data will be invalidated back in time to the point where the last known valid data were recorded and up to the point where the sampler is determined to be operating properly.

Table 22. Site Check Tolerance Limits

Parameter	Tolerance
Wind Speed	±2.2 m/s
Wind Direction	±20 degrees
Ambient Temperature	±3°C
Delta Temperature	±0.5°C
Solar Radiation	±100 W/m^2
Barometric Pressure	±3 mb
Relative Humidity	±20%
PM_{10} and $PM_{2.5}$ Flow	±5%
NO_X	±10%
SO_2	±10%
O_3	±7%
Zero Air	±3 ppb

After the raw data are checked against the site check forms, and any calibration data have been invalidated, the hourly averages are transferred into the project's database in the DASS.

The processing program used by Air Sciences performs some automated QC. For example, all parameters are checked for appropriate variance against manufacturer operating criteria. Data points found to be outside the performance standards of the sensor are investigated. If the variance of the data is outside the criteria in Table 22, then such data are flagged. If irregularities are found, they are investigated in order to determine if the sensor or instrument may be malfunctioning. Corrective action is taken, and data are invalidated as necessary. In cases where the flagged data are actually found to be valid, the technical justification for this finding is documented and the data are included in the final data set.

B.10.2 Data Transmission

All data from the monitoring stations are transmitted via Verizon Wireless broadband from the internal memory of the datalogger or onsite PC. The downloaded data are checked for missed readings as well as against previous downloads to ensure that the data set is complete. In the event that data are found to be missing, the data are downloaded again to determine if the data are in fact not present or have been over-written. The data transmittal and completeness of the data set are recorded in the DASS.

The NO_X, SO_2, O_3, and particulate data are downloaded hourly via serial output to an onsite computer. There are no analog conversions performed on this method of data transfer (i.e., the data download is a direct download). These data are in turn transferred to the DASS using an FTP script via broadband Internet every hour and incorporated into the database system.

The Hewitt Station SoDAR operating system automatically emails data files every 24 hours directly to the DASS via cellular broadband. During periods of unexpected communication outages, the SoDAR system stores any unsent data. When communications are restored, the SoDAR emails all pending files to the DASS. Additionally, the SoDAR data can be manually collected directly from the operating system onto a USB storage device if necessary.

B.10.3 Data Reduction

Data to comprise meteorological hourly averages are collected onsite every one second and placed into temporary storage. The datalogger computes these raw data into 15-minute averages. The 15-minute averages are processed into hourly averages and then placed into permanent storage on the DASS. All particulate data are recorded hourly in actual conditions. Each hourly PM_{10} value is converted to STP values, and then those STP values are averaged to calculate the 24-hour average.

The wind speed, temperature, delta temperature, and solar radiation data are reduced as scalar averages using the following equation:

$$\bar{u} = \frac{1}{N}\sum_{1}^{N} u_i$$

The wind direction data are reduced as a unit vector according to the following equations:

$$V_S = \frac{1}{N}\sum_{1}^{N} S\ i\theta_i$$

$$V_C = \frac{1}{N}\sum_{1}^{N} Cos\theta_i$$

$$\bar{\theta} = A\quad r\ c\left(\frac{V_S}{V_C}\right) + aX\ n$$

If Vc < 0, then X = +180
If Vs < 0, then X = +360
If Vs > 0, then X = +0

The wind direction deviation is reduced using the Yamartino algorithm as follows:

$$\sigma(\theta 1) = ArcSin(\varepsilon)\left[1 + 0.1547\varepsilon^3\right]$$

where $$\varepsilon = \left[1 - \left((V_S)^2 + (V_C)^2\right)\right]^{\frac{1}{2}}$$

and Vs and Vc are as defined above.

The calculations for U and V components provide a vector average for each instantaneous sample of wind direction and wind speed using the following equations:

$$U = \frac{\sum_{i=1}^{N}\left[WS_i * sin(WD_i)\right]}{N}$$

$$V = \frac{\sum_{i=1}^{N}\left[WS_i * cos(WD_i)\right]}{N}$$

After the 15-minute data have been downloaded, they are processed into one-hour averages using in-house software. The same equations listed above are used for the second reduction. Additionally, the format of the 15-minute data is hour-ending. The modeling applications, which utilize these data, require that the data are in hour-beginning format. Therefore, all data are converted to hour-beginning format after reduction.

B.10.4 Data Storage and Retrieval

The data are stored on the Air Sciences server until they have been processed and reported in quarterly reports. At that time, the data are transferred, in triplicate, to optical disc. The optical discs are stored in a climate-controlled environment both on- and offsite for a minimum of five years. Data retrieval is conducted at the request of the Program Director or PCAQCD.

C. ASSESSMENTS AND OVERSIGHT

C.1 Assessments and Response Actions

Ongoing assessments are conducted by the Project Manager and other staff. The results of these assessments are documented in the DASS journal and onsite logbook. The Project Data and Field Technicians are responsible for rapidly following up on all findings, including taking corrective actions for deficiencies and nonconforming conditions. Responses are documented in writing and are reported to the Project Manager.

C.1.1 Site Verification Checks

The NO_X, SO_2, O_3, SoDAR, and particulate instrumentation and the meteorological sensors are checked at least once a week by the Site Operator.

C.1.2 Performance Audits

Performance audits of the sampling systems and meteorological systems occurred upon startup of the project and are conducted by the QA Manager or the Project Data and Field Technicians quarterly or whenever equipment is repaired, replaced, or moved. The meteorological stations are audited or calibrated every six months using rotating equipment and personnel so that the same equipment and personnel are not involved in consecutive six-month audits/calibrations.

C.2 Reports to Management

C.2.1 Quarterly Reporting

Formal reports are prepared quarterly and QA'd by the Project and or QA Manager prior to being sent to the Program Director. These reports are filed with the Program Director within 90 days of completion of a monitoring quarter. These reports include:

1. Project status
2. Monitoring data collected for that period in digital format
3. Sample information:
    a. Sample date and time
    b. Site name and location
    c. Data scheduled to be collected during the reporting period or the reason why the data is missing
    d. Number of possible observations for the quarter
    e. Number of actual valid observations for the quarter
    f. Percent data recovery
    g. Analytical techniques or methods used for sampling

h. Data summaries based on EPA data rules

4. Copies of site check forms
5. Anecdotally conveyed notes and anomalies
6. Corrective actions taken (if any)
7. Data CDs

D. DATA VALIDATION AND USABILITY

D.1 Data Review, Validation, and Verification Requirements

D.1.1 Data Review QA Levels

Generally, there are four "levels" of air quality and meteorological data validation. When a data set has undergone a level of review, it passes on to the next level. The process is used to determine the validity of the data.

- Level 0 validated data are essentially raw data obtained directly from the DASS in the field. Level 0 data have been reduced and possibly reformatted but are not edited or reviewed. These data have not been adjusted for known biases or issues that may have been identified during preventive maintenance checks or audits. These data may be used to monitor instrument operations on a frequent basis but should not be used to satisfy permit conditions, to compare against reporting thresholds and applicable air quality standards, or as input to dispersion models.

- Level 1 data validation involves quantitative and qualitative reviews for accuracy, completeness, and internal consistency. Quantitative checks are performed by DASS software screening programs, and qualitative checks are performed by meteorologists or field staff who manually review the data for outliers and other anomalies. Quality control flags are assigned, as necessary, to indicate the data quality. Data are only considered validated at Level 1 after final audit reports have been issued and any adjustments, changes, or modifications to the data have been made and documented.

- Level 2 data validation involves comparisons with independent data sets. This function includes, for example, making comparisons to other meteorological or ambient pollution data or upper-air measurement systems.

- Level 3 data validation involves a more detailed analysis and final screening of the data. The purpose of the final step is to verify that there are no inconsistencies among the related data (such as issues with scalar and vector data or inconsistencies with relative humidity during precipitation events, etc.). Graphics programs may be run to examine the overall consistency among related data (e.g., checking diurnal patterns against other parameters or reviewing strip charts for final analysis). Data sets that pass Level 3 QC review are appropriate for use to satisfy permit conditions, to compare against reporting thresholds and applicable air quality standards, and as input to dispersion models.

D.1.2 Data Calculations

D.1.3 Particulate Data

Particulate data are measured and initially stored in **Actual** conditions. All PM_{10} particulate data are converted by the screening program to STP values using the following equation:

Correcting Actual Particulate Concentrations to Standard Conditions

$$Q_s = Q_a * \left(\frac{P_a}{T_a} \right) * \left(\frac{298}{760} \right)$$

T_a = Ambient Temperature (Kelvin) (Kelvin = Celsius + 273)
P_a = Ambient Barometric Pressure (mmHg)
Q_a = Actual Volumetric Flow from Reference Meter

D.2 Verification and Validation Methods

Data validation refers to the review process in which data are screened for errors and anomalies. All data validation is done in accordance with EPA method-specific procedures. Significant anomalies are flagged or notated in the quarterly reports. All suspect data are investigated further.

D.3 Reconciliation with User Requirements

Changes in the end-user requirements of the instrumentation may be necessary from time to time. Some changes may require altering costs, data, and/or reporting turnaround time, and/or modifying existing (or developing new) SOPs. Changes will be accommodated, when technically feasible, according to the following procedure:

- The QA Manager will notify the Project Manager of the changes.
- The impact of the requested changes (costs, turnaround times, SOPs) will be communicated in the notification.
- Any limitations on the use of the data will also be communicated.
- The Project Manager will shall approve any changes in this procedure.
- Documentation (as an addendum to this monitoring plan) of the changes will be provided.

Any changes involving the sampling methods, detection limits, or new parameters will be submitted to PCAQCD for review and approval prior to implementation.

ABBREVIATIONS AND ACRONYMS

ABS	Absolute
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AERSURFACE	Tool to obtain surface characteristic values for input into AERMET
BAM	Beta Attenuation Monitor
BP	Barometric Pressure
CFR	Code of Federal Regulations
CL	Confidence Limit
CV	Coefficient of Variation
DASS	Data Acquisition Storage System
Delta T	Temperature Difference
DQO	Data Quality Objective
EPA	United States Environmental Protection Agency
FEM	Federal Equivalent Method
FR	Flow Rate
FTP	File Transfer Protocol
HVAC	Heating, Ventilating, and Air Conditioning
LDL	Lower Detection Limit
lpm	Liters per Minute
mb	Millibars
MFGR	Manufacturer
mg	Milligrams
mmHg	Millimeters of Mercury
MQO	Measurement Quality Objective
m/s	Meters per Second
NEPA	National Environmental Policy Act
NIST	National Institute of Standards and Technology

ABBREVIATIONS AND ACRONYMS – CONTINUED

NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
O_3	Ozone
PAMS	Photochemical Assessment Monitoring Station
PCAQCD	Pinal County Air Quality Control District
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter with an Aerodynamic Diameter less than 2.5 Microns
PM_{10}	Particulate Matter with an Aerodynamic Diameter less than 10 Microns
ppb	Parts per Billion
ppm	Parts per Million
PSD	Prevention of Significant Deterioration
QA	Quality Assurance
QC	Quality Control
RCC	Resolution Copper Company
RCML	Resolution Copper Mining LLC
RH	Relative Humidity
RSD	Relative Standard Deviation
SD	Standard Deviation
SLAMS	State and Local Air Monitoring Station
SoDAR	Sonic Detection and Ranging
SOP	Standard Operating Procedure
SO_2	Sulfur Dioxide
SRL	Surface Roughness Length
STP	Standard Temperature and Pressure
$\mu g/m^3$	Micrograms per Cubic Meter
W/m^2	Watts per Square Meter

Appendix A – Site Check and Audit Forms

Appendix B – Standard Operating Procedures

Appendix C – PCAQCD Monitoring Plan Approval Letter